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MANUAL

OF THE

ORTHOPTERA OF NEW ENGLAND,

INCLUDING THE

LOCUSTS, GRASSHOPPERS, CRICKETS, AND THEIR ALLIES.

By ALBERT P. MORSE.

BOSTON, MASS.
PRINTED FOR THE SOCIETY
WITH AID FROM THE
Gurdon Saltonstall Fund.
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&Insects

TO

E. B.

WITHOUT WHOSE CONSTANT INTEREST AND ENCOURAGEMENT THIS BOOK COULD NOT HAVE BEEN WRITTEN.

"Wherefore we ought not childishly to neglect the study even of the most despised animals, for in all natural objects there lies something marvelous."—ARISTOTLE, *On the Parts of Animals, Book V, 5, 4.*

PREFATORY NOTE.

It once became my duty to identify some specimens of Grasshoppers, Locusts, and Crickets captured in Wellesley and vicinity. The difficulties with which I met as a novice in so doing, and in later study of the group, together with the lack of correct and definite recorded information relating to the seasons, haunts, habits, and distinguishing characters of these insects, led me to collect them extensively in the hope of finding out for myself how many kinds inhabited New England, and of being able to simplify for others the task of identifying them. After the lapse of many years and numerous interruptions this Manual is the outcome. If it serves its purpose as an aid, stimulates interest, and satisfies a natural desire for information concerning a conspicuous type of the insect life about us, I shall feel repaid. There still remains to be secured a large amount of data bearing on the exact distribution, seasons, and particular habits of the less common species.

Since an appeal to the eye speaks louder than words, and memory pictures of its characteristic environment make an essential part of a first-hand knowledge of the life of each organism, I have added several photographs of different types of habitat in which these insects live.

The colored plates (drawn with painstaking care by Mr. E. N. Fischer) represent a few of the more attractively colored species and some of the interesting phases of coloration exhibited by these insects.

Acknowledgments are due to many kind friends, some of whom are no longer living, for aid rendered in various ways: for specimens, to A. L. Babcock, J. Barlow, Wm. Beutenmüller, F. P. Briggs, Mrs. W. F. Buck, Wm. T. Davis, Messrs. S. F., S. W., and W. D. Denton, J. H. Emerton, Miss Susy C. Fogg, C. A. Frost, R. W. Glaser, Dr. J. L. Hancock, Prof. F. L. Harvey, Prof. Marian E. Hubbard, C. W. Johnson, C. J. Maynard, Prof. Herbert Osborn, Prof. H. M. Parshley, E. J. Smith, F. H. Sprague, B. H. Walden, Dr. E. M. Walker, Prof. C. M. Weed, Rev. H. W.

Winkley; for information regarding localities, O. Bangs, Miss Susy C. Fogg, E. F. Hitchings, Prof. S. I. Smith; for access to collections in their charge, Prof. W. E. Britton, Prof. C. H. Fernald, Prof. H. T. Fernald, Samuel Henshaw, Dr. Edith M. Patch, S. H. Scudder; for data on distribution, systematic characters, and information regarding terminology, Wm. T. Davis, B. B. Fulton, Morgan Hebard, J. A. G. Rehn; for aid derived from their published works, Prof. W. S. Blatchley, Wm. Beutenmüller, A. N. Caudell, Prof. C. H. Fernald, B. B. Fulton, Dr. J. L. Hancock, Prof. C. A. Hart, Morgan Hebard, J. A. G. Rehn, S. H. Scudder, R. E. Snodgrass, B. H. Walden; for accented list of scientific names and quotation from Aristotle, Prof. K. M. Edwards; and for his résumé of breeding experiments on inheritance of color in Chortophaga, Dr. P. W. Whiting. For the loan of cuts and plates thanks are due Dr. L. O. Howard of the United States Bureau of Entomology, W. S. Blatchley, Prof. E. M. Walker, the State Entomologists of Minnesota and Connecticut respectively, and the State Experiment Station at Geneva, N. Y., as duly accredited elsewhere.

I am deeply grateful to all the persons mentioned. They have contributed appreciably to the information which I have here brought together in the hope that it will clear away difficulties and awaken interest in the New England insects of this group. Nor can I forget my debt to Professor M. A. Willcox, who set me in the path, and to Professor J. H. Comstock, my first instructor in the science of entomology, whose training led to many happy hours in the laboratories, fields, and ravines of Ithaca, and in after years in the wilderness trails of the far West and South.

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INTRODUCTION.

The Orthoptera form a group of insects whose members touch upon man's interests in a variety of ways. Some are among the scourges of the earth, devastating wide areas, reducing the inhabitants to penury and starvation and leaving in their wake misery and pestilence. Others of obnoxious character enter dwellings in search of food and shelter, and though acting in part as scavengers destroy large quantities of food-stuffs and defile the premises. Wherever he wanders, whether on some nameless peak of the farthest ranges or in the less inviting vacant lot next door, by seabeach, grainfield, alkali desert, or mangrove swamp, on city pavements or yielding footpath to the spring, these little creatures are his companions; whether he sleep in hut or palace or beneath the stars their voices soothe his rest.

The beauty and variety of tints worn by some species stir our admiration; our curiosity is aroused by the singularity of form in others; protective coloring and resemblance lay a wonder-working mantle of invisibility on many. Their songs are everywhere associated with life, often joyous but more frequently in the minor-keyed moods at the passing of the year. Science questions them on problems of distribution, adaptation, phylogeny, and inheritance. Altogether, they affect human life in many ways—economically, scientifically, educationally,—and their aesthetic interest is not the least in importance, as the many references in literature testify.

Our New England species have received their share of attention, both literary and scientific, in times past, but much still remains to be learned. In the literary field, Oliver Wendell Holmes's poem "To a Katydid" is probably best known; it is characteristically Holmesian in its treatment, and decidedly more literary than scientific. To the songs of Crickets numerous allusions are made in the writings of Hawthorne, Holmes, Longfellow, Thoreau, Elizabeth Akers Allen, and others, the best of all being the poem by Harriet McEwen Kimball beginning

"Pipe, little minstrels of the waning year."

Introductory Literature.

To the student of Orthoptera who seeks to gain an acquaintance with their North American representatives, three works by S. H. Scudder are indispensable as a foundation. The first is the "Guide to the Genera and Classification of North American Orthoptera" (Cambridge, 1897, E. W. Wheeler, publ.) which contains keys to the genera then recognized, bibliographical notes, and a list of the works referred to. (2) Scudder's "Index to North American Orthoptera," published by this Society in 1901 (Occasional Papers, vol. 6), contains all known references up to that year and a complete bibliography of the literature cited. (3) Scudder's "Catalogue of the Described Orthoptera of the United States and Canada" (Proc. Davenport Acad. Nat. Sci., 1900, vol. 8) lists the species known at that time, and states their general distribution.

Two excellent introductory works on the Orthoptera of Indiana and Minnesota but of much wider general application, have been published. The first is by Professor W. S. Blatchley (27th Ann. Rept. Dept. Geol. and Nat. Resources of Indiana for 1902, 1903, vol. 9, p. 123–471); the second by Professor Otto Lugger (3d Ann. Rept. State Exp. Sta., Univ. Minn. for 1897, 1898, xi+ 296 pp.). From these two works many of the illustrations in this Manual are drawn.

For further references to helpful literature the family headings in the following pages should be consulted.

History of New England Orthopterology.

In the scientific field we are indebted to Dr. T. W. Harris for the first considerable account of our Orthoptera in his "Report on the Insects of Massachusetts" published in 1833 but better known in the edition of 1862 under the name: "A Treatise on some of the Insects injurious to Vegetation." In this work about fifty pages of text, four colored figures, and seventeen woodcuts were devoted to these insects. Dr. Harris enumerated 39 species, chiefly Acridians; a fourth of these are synonyms but several of our Orthoptera were first described by him.

In 1862, an important paper of 71 pages, by S. H. Scudder, appeared in the Boston Journal of Natural History, published by this Society, entitled "Materials for a Monograph of the North American Orthoptera, including a Catalogue of the Known New England Species." This listed 78 species from New England, of which 17 names are now relegated to synonymy and two are of kinds which do not occur here; however, the names of 14 of our species date from the publication of this paper. It was followed at frequent intervals during the remainder of the century by a remarkable series of articles by the same author, of varied character, biologic and systematic, on North American Orthoptera. Many of these were based on or contained references to New England material. A full list will be found in Scudder's "Alphabetical Index to North American Orthoptera" published by this Society in 1901. References will be made to certain ones later.

In 1868, Professor Sidney I. Smith, of Yale University, published a brief article of nine pages in the Proceedings of the Portland Society of Natural History entitled, "On the Orthoptera of the State of Maine," in which he enumerated all the species recorded or known by him to inhabit that State, totalling 38, and described "*Pezotettix manca*," the *Melanoplus mancus* of this Manual. This article was followed, in his Report of the Entomologist to the Connecticut Board of Agriculture for the year 1872, by a short account of the Orthoptera of that State, in which he treated briefly some 40 species and added a list of the Orthoptera of Connecticut, enumerating 61. Of this number, 8 are synonyms and 3 do not occur in that State.

One of Scudder's papers which requires mention here is that on "The Distribution of Insects in New Hampshire" (Hitchcock's Rept. Geol. N. H., 1874, vol. 1, p. 331–380). This contains a "List of the Orthoptera of New Hampshire, with Notes on their Geographical Distribution and Stridulation."

In 1888, Professor Charles H. Fernald published in the Report of the State Board of Agriculture of Massachusetts, an article of 61 pages entitled, "The Orthoptera of New England." This may be said to be the first work devoted solely to the Orthoptera of the same territory covered by this Manual. It was a useful introduction to the order as found in New England, designed for

the use of students in the Massachusetts Agricultural College and the farmers of the State. It contains a brief synonymical list, glossary, elementary account of the external and internal anatomy, and is illustrated by 22 woodcuts. It treats of 71 species; of these 2 are not found within our limits and 8 names fall into synonymy. Being primarily a compilation, based on a small amount of material and limited personal experience, it could not but prove, notwithstanding its numerous merits, unsatisfactory in some respects, particularly in regard to diagnostic characters and data of time and place, since in but two instances were dates mentioned and but rarely were localities stated.

The present writer became interested in the group in 1891, during general entomological collecting and study. His first systematic paper constituted a revision of the New England species of Orphulella and described *O. olivacea* from Connecticut (Psyche, vol. 6, p. 477–479, 1893). In 1894, his revision of the New England species of Spharagemon including one new species was published in the Proceedings of this Society and a "Preliminary List of the Acrididae of New England" appeared in Psyche. In the same year he began to publish his "Notes on New England Acridiidae" in Psyche. These continued until 1898; they contained keys for identification, diagnostic sketches, bibliographical and synonymical references, records, numerous biological data, and practically formed a brief monograph of the New England members of that family up to the date of publication.

"A Descriptive Catalogue of the Orthoptera found within Fifty Miles of New York" by William Beutenmüller, published in 1894, (Bull. Amer. Mus. Nat. Hist., vol. 6, p. 253–316, pl. 5–10) requires mention since its field includes a part of New England. It covered the entire order, contained helpful drawings of 63 species, and directed attention to certain neglected groups, particularly the Tree-crickets, of which two of our species had previously been described by the same author. The terminology used is now considerably out of date.

In 1900, Scudder's "List of the Orthoptera of New England" was published (Psyche, vol. 9, p. 99–106, 1900). In this he

recorded, with brief annotations, 98 species, to which were later added 6 (p. 119), making 104. From these must be deducted 7 wrongly recorded or synonymous, leaving 97.

In 1911, appeared "The Euplexoptera and Orthoptera of Connecticut" prepared by B. H. Walden of the Connecticut Experiment Station (Conn. Geol. and Nat. Hist. Surv., bull. 16, p. 39–169, pl. 6–11). This excellent work of 130 pages contains keys to species, diagnostic drawings, 55 half-tones from photographs, a very brief introduction, good descriptions, notes and data on 106 species, but of course does not include a number of the boreal kinds which live farther north. Of the 106 listed, 11 are as yet undetected or synonymous, leaving a total of 95.

The present work includes 132 species, of which 16 are regarded as adventive and believed not to have become established, or if so, but for a brief period. One other species has not been captured in New England for a half century. It is probable that additional forms remain to be added from southern Connecticut, our western border, and possibly from northern Maine (*see* Table of Native and Exotic Orthopteroidea recorded from New England, p. 263).

Collections of New England Orthoptera.

Historically, the Harris Collection of Massachusetts Orthoptera is the oldest one of New England material. Unfortunately, this has all been destroyed but a few fragments. The collection of S. H. Scudder, now in the Museum of Comparative Zoölogy at Cambridge, Mass., is the most important in the number of types which it contains, 26 of our species having been described by him. Professor S. I. Smith's collections from Maine are in the same museum, together with much material gathered by Professor A. S. Packard, Samuel Henshaw, and F. H. Sprague. The several State experiment stations have collections, the larger being those at Amherst, Mass., and New Haven, Ct. The Boston Society of Natural History possesses a small but good series of specimens secured in large part by the Curator, C. W. Johnson, during his trips to many parts of the New England

States. My personal collection, at Wellesley, Mass., numbers several thousand specimens, and is the largest, most nearly complete, and most representative, containing material from nearly all sections of the district, but it still lacks New England examples of several of the recorded species.

Classification.

The insects generally referred to the order Orthoptera are the Earwigs, Cockroaches, Praying Mantids, Walking-sticks, true Locusts, Grasshoppers, and Crickets. These are sometimes classified in two orders, the Dermaptera or Euplexoptera, containing the Forficulidae or Earwigs, and the Orthoptera *genuina*, including the remaining six families under the names of Blattidae, Mantidae, Phasmidae, Acrididae, Locustidae, and Gryllidae. This is the classification, sequence, and terminology used in Comstock's "Manual of Entomology" and many other works. It is the sequence proposed by Brunner von Wattenwyl in his "Révision du Système des Orthoptères" (1893), followed by Scudder in his "Guide to the Genera and Classification of the North American Orthoptera" (1897), and is probably the most familiar to entomologists in general.

The six so-called families of Orthoptera vary greatly in degree of relationship to each other, a condition which is not expressed by this classification. The Long-horned Grasshoppers and the Crickets are evidently closely related, and with the Locusts, which differ more widely from them, are conveniently and appropriately united in a group called the Saltatoria or jumping Orthoptera. The remaining three families, or non-saltatorial Orthoptera, differ much from the Saltatoria and from each other.

The modern ideas regarding the relationship and proper classification of these insects, as represented by the views of Handlirsch,[1] which were based on palaeontology, embryology, and probable lines of descent, have been embodied to a large extent in a classification recently published by Brues and Melander.[2] In

[1] Handlirsch, A. Die fossilen Insekten und die Phylogenie der rezenten Formen. Leipzig, 1908.

[2] Brues, C. T., and Melander, A. L. Key to the families of North American insects. 1916.

this the typically winged insects (class Pterygogenea) are divided into eleven subclasses, and those comprising the old order Orthoptera are re-arranged as follows:—

Class Pterygogenea.
Subclass Orthopteroidea.
(Order Grylloblattoidea—one species,—Rocky Mts.)
Order Orthoptera.
Suborder Acridoidea—Acridiidae, Tettigidae.
Suborder Locustoidea—Locustidae, Gryllidae, Gryllotalpidae, Tridactylidae.
Order Phasmoidea—Phasmidae.
(Order Diploglossata—Hemimeridae,—So. Africa.)
Order Dermaptera—Earwigs, with four families.
(Order Thysanoptera—Thrips,—two suborders and three families.)
Subclass Blattaeformia.
Order Mantoidea—Mantidae.
Order Blattoidea—Blattidae.
Five other orders, including the termites, bark-lice, bird-lice, and sucking lice.

In the present work, which is intended for relatively general and popular use, it seems wisest to be somewhat conservative and adopt a modified form of the customary arrangement, as follows:—

Order Dermaptera.
Order Orthoptera.
Family Blattidae.
" Phasmidae.
" Mantidae.
" Tettigoniidae.
" Gryllidae.
Subfamilies Gryllinae, Oecanthinae, Trigonidiinae, Gryllotalpinae, Tridactylinae.
Family Acrididae.
Subfamilies Acridinae (=Tryxalinae), Oedipodinae, Locustinae (=Acridiinae), Acrydiinae (=Tettiginae).

In this arrangement of the groups it will be noticed that I have placed the Acrididae after the Tettigoniidae and Gryllidae, and the Burrowing Crickets and Pygmy Locusts (Acrydiinae) last in their respective families. I have done so on the ground of the greater specialization of structure which they exhibit.

Anatomy.

A knowledge of the general structure of at least one representative of the order is a necessary preliminary to the identification of these insects. Details will be studied as need arises.

For general purposes an example of any large species of Locust is satisfactory, and a particularly good and easily recognized one is the Carolina or Black-winged Locust, *Dissosteira carolina*,

Fig. 1.—Carolina Locust (*Dissosteira carolina*). Wings of right side spread. (After Lugger.)

popularly called "Quaker" or "Flying Grasshopper." This species is from one and a half to two and an eighth inches long from front of head to tip of closed wings, the wing-covers and body are brown or gray of various shades, the wings are black, bordered on the hinder margin with buffy white. It is common in August and September in open sandy fields, on roadsides, gravel banks, seabeaches, and waste lands generally, inhabiting all the warmer parts of the country from Maine to Florida and California. In its absence any large species will answer and the accompanying outline sketches will serve if specimens are not at hand.

The Insect Body and Skeleton.

The body of an insect is made up of three general regions: head, thorax, and abdomen. These three parts are conspicuous in ants, bees, and wasps, but less noticeably distinct in other orders of insects. The head bears the eyes, 'feelers' or antennae, and mouth-parts. The thorax bears three pairs of legs, and typically two pairs of wings. The abdomen forms the remaining posterior portion of the body, and at its tip bears appendages of variable size and character which are used as sense organs, for defence, for securing prey, in mating, or in depositing the eggs.

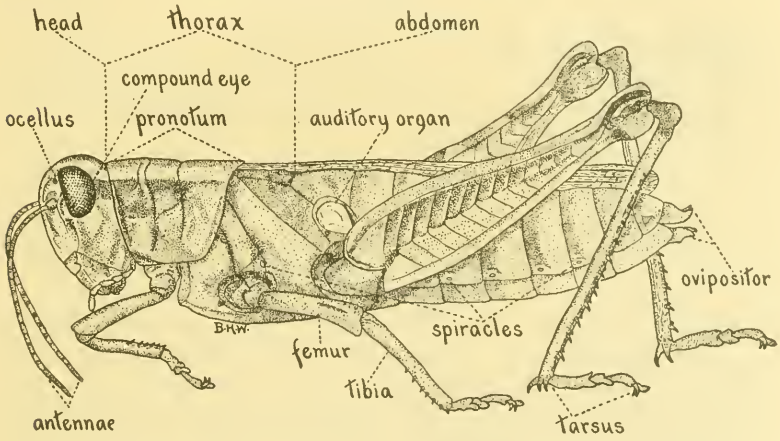

Fig. 2.—Drawing of Locust, side view, showing chief parts. Enlarged. (After Walden.)

The supporting skeleton of an insect is chiefly external, instead of internal as in the higher, backboned animals, occupies the place that the skin does in them, and forms the body-wall. It is composed largely of a peculiar horn-like substance named *chitin,* which is deposited in variable amounts in different parts of the body-wall, forming stiff, somewhat elastic portions (*sclerites*) connected by soft and pliable areas which allow movement. Sometimes the sclerites are immovably joined but their limits may usually be distinguished by lines or narrow grooves termed *sutures.* Motion is effected by muscles enclosed within the body-wall, extending from one segment to another.

The ring-like segments of the middle of the abdomen (Fig. 1–3)

are joined together end to end in a longitudinal series, the hind margin of the anterior slightly overlapping the anterior margin of the posterior. Each segment consists of a long dorsal sclerite (*tergum* or *tergite*) united laterally to a shorter ventral piece (*sternum* or *sternite*) by a pliable membranous area which provides for expansion of the body during breathing. The term *pleurum* or *pleuron* (plural *pleura*) is sometimes applied to the lateral part of the entire body or of a segment; or *pleurite* may

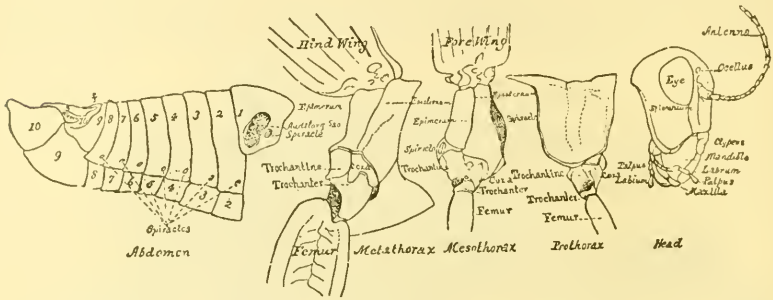

Fig. 3.—Drawing of body of Locust, side view, showing thorax separated from head and abdomen, and divided into its three segments. (After Packard.)

be used for the latter. In the abdomen there is no line of division between the pleurite and tergite and the latter term is commonly used for both. The entire body of an insect is regarded by embryologists as composed of a series of twenty segments (*somites, metameres*) of which six belong to the head, three to the thorax, and eleven to the abdomen. In the adult these segments are united in various degrees, being quite distinct in the middle of the abdomen but unrecognizable in the head.

Anatomy of a Locust.

Head.

In this Locust the head (Fig. 2–5) is ovoid in form, somewhat compressed from side to side, placed nearly at right angles to the axis of the body, with the mouth on the lower or ventral side. The large oval compound eyes are conspicuous objects embedded in and projecting from the sides of the upper portion (*epicranium*). If examined with a compound microscope

or powerful hand-lens their surface will be seen to be made up of a large number of minute hexagonal areas called facets, each of which is the external end of a single eye element or *ommatidium* (plural *ommatidia*) with a convex surface (*lens*). Three simple eyes (*ocelli*, singular *ocellus*) are situated, one in the middle of the prominent ridge running down the middle of the face, the others on each side of the ridge opposite and very near the middle of the front margin of the compound eyes. Below each lateral ocellus is a pit (*fossa*) from which arises a 'feeler' (*antenna*). The antennae consist of a series of joints or segments varying greatly

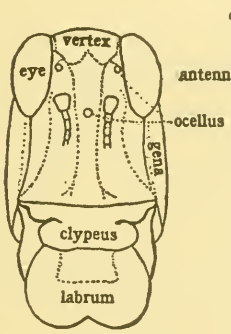

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Fig. 4.—Front view of head of Locust. Enlarged. (Original.)

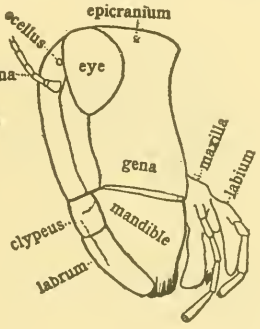

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Fig. 5.—Side view of head of Locust. Enlarged. (Original.)

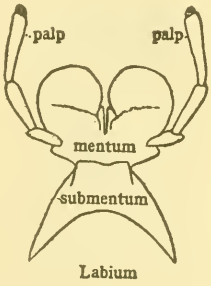

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Fig. 6.—Ventral view of labium of Locust. Enlarged. (Original.)

in number and form in different members of the family but are always recognizable by their position and character. They are sense organs, believed to be tactile in function in the Orthoptera, and perhaps are equipped with other senses as well.

The smooth, convex top of the head is called the crown of the head; its posterior portion the *occiput* or hind head, a term which is best restricted to the turned-in part surrounding the Locust's neck. The part between and in front of the compound eyes is the *vertex;* by some authors the crown is included in the term vertex. The vertex often bears a depression (*scutellum verticis*) sometimes marked in the median line by a faint ridge (*carina*) and may be bounded in front by elevated ridges; the tip of the vertex where it joins the frontal *costa* or facial ridge is the *fastig-*

ium. Below the lateral ridges or edges of the fastigium there are sometimes flattened or depressed areas (*foveolae*), the form and location of which are useful in diagnosis.

The convex portions of the head behind and below the eyes are the cheeks or *genae* (singular *gena*). Running downward from the lower corner of the eye is a suture; this separates the anterior from the lateral parts of the epicranium, the *front* from the *genae.* At their lower ends these sutures are connected by a deep transverse groove across the face, below the front. The fixed or rigid sclerite below this suture is the *clypeus;* attached to this on its

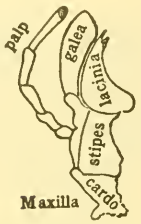

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Fig. 7.—Ventral view of maxilla of Locust. Enlarged. (Original.)

8

Fig. 8.—Mesial view of mandible of Locust. Enlarged. (Original.)

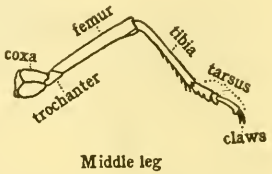

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Fig. 9.—Rear view of right middle leg of Locust. Enlarged. (Original.)

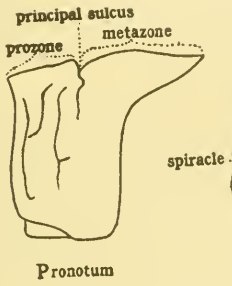
lower edge is the upper lip or *labrum.* The front is divided into five parts: the median ridge or *frontal costa,* the paired antennal grooves (or *scrobes,* or *fossae*), and the lateral portions adjoining the cheeks.

Attached to the lower border of the cheeks are the paired *mandibles,* strong, hollow, sac-like outgrowths with black, irregularly toothed distal edges, used for biting off fragments of vegetation. These are covered in front by the upper lip (*labrum*) and behind and below by the remaining mouth-parts which can be well studied only after the head is removed by severing the membrane of the neck. This should be cut directly behind the head.

In the severed head a reflexed hinder part is noticeable, narrow dorsally (*occiput*), and broadening laterally into triangular *post-genae.* Covering the hinder part of the ventral portion of the head is the lower lip or *labium.* This consists of a basal, short, widely U-shaped or crescentic sclerite extending between

the inner angles of the post-genae and termed the *sub-mentum*, which in turn bears distally a complicated structure, the *mentum*. The mentum bears, on a pair of lateral protuberances (*palpigers*), the three-jointed labial palps (singular *palpus*, plural *palpi*) and distally a pair of semicircular *paraglossae*. In the deep median cleft between these latter is a pair of tiny *glossae* (singular *glossa*). Attached basally to the inner (front) side of the labium is a thick, fleshy tongue (*hypopharynx*).

Between the labium and the mandibles lies a pair of accessory jaws, the *maxillae*, of complicated structure, whose function is to handle the food rather than grind it. Each maxilla is composed



10

Fig. 10.—Side view of pronotum of Locust. Enlarged. (Original.)

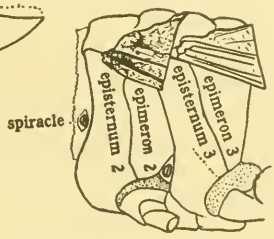


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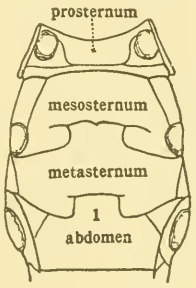
Fig. 11.—Side view of meso- and metathorax of Locust. Enlarged. (Original.)



12

Fig. 12.—Ventral view of thorax of Locust. Enlarged. (Original.)

of a basal segment (*cardo*) which supports distally a quadrate sclerite (*stipes*); this in turn bears a triangular, black-toothed *inner lobe* (*lacinia*), and laterally a small basal sclerite (*palpifer*) bearing laterally the long five-segmented *maxillary palpus*, and distally a narrow *sub-galea* (attached also to the stipes) which supports at its end the broad *outer lobe* or *galea*. When closed, the labrum, galeae, and paraglossae completely hide the tips of the mandibles and laciniae. Both the labial and the maxillary palps have at the tip a cushion-like area bearing many sensory papillae, probably organs of taste.

Thorax.

The thorax (Figs. 10, 11, 12) consists of three parts or segments: an anterior *prothorax* bearing ventrally the first pair of legs; this

is movably connected with the succeeding middle or *mesothorax*, which bears the second pair of legs and a pair of long narrow wing-covers or *tegmina* (singular *tegmen*) above; this segment is rigidly joined to the hind or *metathorax*, which bears the large hind legs and the broad, black, membranous wings.

The three thoracic segments are believed to present the same plan of structure greatly modified in details. The ventral face of each is stiffened by a single sclerite, the *sternum*. On each side are two pleural sclerites, the *episternum* and *epimeron*. Each *dorsum*, *tergum*, or *notum* is composed of four sclerites arranged in a longitudinal series and named from before backward the *praescutum*, *scutum*, *scutellum*, and *post-scutellum*. To these terms are attached prefixes pro-, meso-, and meta-, to indicate the particular segment, *e. g.*, the metepisternum is the episternum of the metathorax.

The prothorax consists principally of a large dorsal piece, the *pronotum*, which in many Locusts and Grasshoppers is saddle-shaped, but which in this species and some of its allies bears a high median ridge (*mid-carina*) cut deeply in front of the middle by a groove, *sinus*, or *sulcus* which extends downward nearly to the ventral edge of the pronotum. This is the *principal sulcus* and it lies between the third and fourth dorsal sclerites (scutellum and post-scutellum) of the prothorax. That part of the pronotum in front of it is termed the *prozona* or prozone, behind it the *metazona* or metazone. About on a level with the points of attachment of the wing-covers and running forward will be found the low, dull *lateral carinae*, in this species interrupted in the middle but usually very distinct in the Slant-faced Locusts (Tryxalinae = Acridinae of this Manual). These separate the top or *disk* of the pronotum from the sides or *lateral lobes*. By close scrutiny other sutures may be seen in addition to the principal sulcus, extending for the most part dorso-ventrally and indistinctly indicating the other sclerites of which the pronotum is made up. At the lower front edge of the lateral lobes is a small triangular sclerite, the pronotal episternum; its companion epimeron is lacking. The prosternum is a curiously sculptured plate with three deep pits, extending between the bases of the front legs. In the neck-membrane, on each side just above and in front of the episternum is a pair of very small, linear *jugular*

sclerites, which aid in supporting the head. These show better in the Dusky Locust (*Encoptolophus sordidus*), black in a brown membrane. The hind margin of the disk of the pronotum extends backward to form a right angle and is often referred to as the *hind process* of the pronotum. In the membrane connecting the prothorax and mesothorax, under the ventral portion of the lateral lobes, one on each side, are the prothoracic *spiracles*, openings into the system of air-tubes (*tracheae*, singular *trachea*) which conduct air to all parts of the body. Directly above the fossa from which arises the middle leg is another spiracle, guarded by a pair of lips which open in a nearly vertical plane, and surrounded by a narrow sclerite termed a *peritreme*. These are the mesothoracic spiracles.

The mesothorax is rigidly united to the metathorax. Ventrally the sterna of these two segments appear as broad transverse plates, notched in the mid-line posteriorly by a wide quadrate interspace. The mesosternal interspace is occupied by a part of the metasternum, the metasternal interspace by a corresponding part of the first abdominal segment. Laterally, the four pleural plates (mes- and metepisterna and epimera) appear as rather narrow, elongate, somewhat oblique sclerites extending from the sterna and fossae of the legs dorsally to the notum and attachment of the wings. In some species of Melanoplus the metepisternum is characteristically marked by an oblique pale stripe.

The dorsum of these two segments of the thorax is entirely covered by the hind process of the pronotum, and the bases of the tegmina and wings. When exposed it presents an intricately sculptured surface composed mainly of four sclerites,—the scutum and scutellum of each of the two segments.

Appendages of the Thorax: Legs.—Each leg (Fig. 9) is made up of a series of segments of which a short, somewhat conical basal one, the *coxa* (plural *coxae*), is attached to the thorax in such a way as to allow movement in every direction. To it a long segment, the thigh or *femur* (plural *femora*) is articulated by a hinge-joint moving vertically. Next comes a long shank (*tibia*, plural *tibiae*), armed beneath in the front and middle legs, above in the hind legs, with two rows of stiff black spines. On the front and middle legs these are movably attached, on the hind legs rigidly, with the exception of two pairs of longer spurs at the

distal end. The last section of each leg consists of the foot or *tarsus* (plural *tarsi*) and comprises three joints: a long basal one bearing three soft pads beneath, a short second joint also bearing a pad, and a long and narrow distal joint bearing at its end a pair of sharp claws with a pad between them. The pads or cushions are called *empodia* (singular *empodium*) or *pulvilli* (singular *pulvillus*). They are very much larger in the Slant-faced and Spine-breasted Locusts which perch much more on plants than do the Band-winged group to which the Carolina Locust belongs. Since the typical number of segments in the insect tarsus is five, and the proximal segment in that of the Locust bears three pulvilli, it is regarded as three segments fused together, and an example of specialization of structure. The hind femora and tibiae are elongated and the femora greatly enlarged in comparison with those of the other legs; this is a case of specialization for the purpose of leaping. In order to understand the reasons for the location of the tibial spines and their respective positions on the several pairs of legs, one should study a living Locust and watch its actions while it walks and leaps. Only in this way can one comprehend the action of the spines and spurs in conjunction with the claws to secure a good footing or aid in leaping or pushing a way through vegetation.

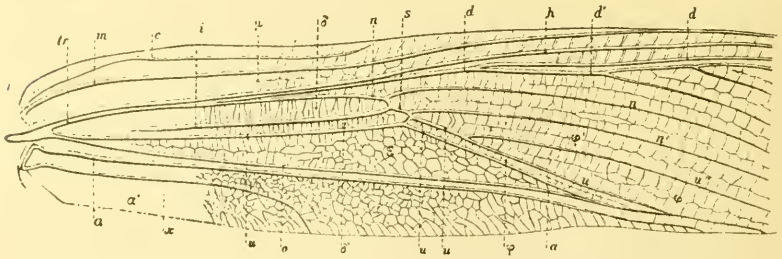


Fig. 13.—Part of right tegmen of Locust, showing venation. (After Saussure.)

Wings.—These are four in number: a long, narrow, unfolded anterior pair attached to the mesothorax; and a broad, posterior, metathoracic pair, folded in fan-like plaits. The front pair are thickened to form protective wing-covers or *tegmina* (singular *tegmen*). The hind ones are the flying organs, aided to some degree by the front pair. The wings are not appendages in the same sense as the legs, but are plate-like expansions of the body-

wall which grow out as flat, hollow sacs containing blood and air-tubes (tracheae). Later, their walls unite, and linear thickenings along the walls of the tracheæ form longitudinal supporting ribs termed *veins* or *nerves*. The arrangement of these, termed venation or neuration, is of much importance in classification.

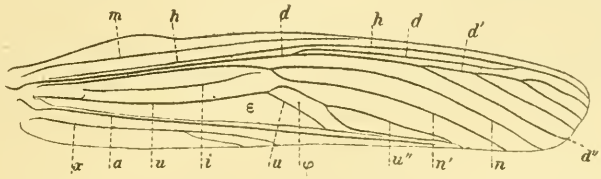


Fig. 14.—Right tegmen of Carolina Locust, showing venation. (After Saussure.)

Between the veins run numerous cross-veins, *venules* or veinlets, very thickly and irregularly placed on the base of the tegmina, fewer and more regularly arranged near the end of the tegmina and on the wings.

The names of the various parts of the tegmen and wing, of the veins and the spaces between them, can most quickly be learned from the figures. (See Figs. 13, 14.) In the Band-winged Locusts

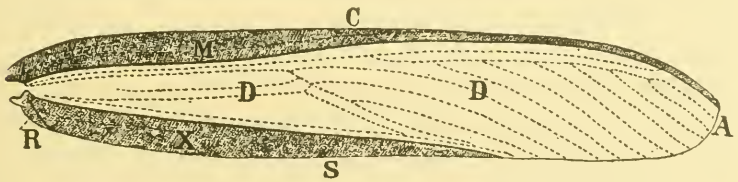


Fig. 15.—Right tegmen of Locust, with areas indicated. (After Saussure.)

the wings are often brightly colored and bear a conspicuous dark transverse band. This divides the wing into a basal area (*disk*), the seat of the most brilliant color, and a clear, smoky, or spotted apex. The transverse dark band usually sends off, near the front margin of the wing, a small branch toward the base of the wing, which extends a distance varying with the species.

"The principal veins of the tegmina of a locust diverge from the basal end and are seven in number. The one nearest the front or lower margin of the wing-cover is the 'sub-marginal' or 'costal vein' (*c*). It is undivided, and may usually be traced for

a little more than half the length of the tegmina, though in some locusts it is lacking. The second and longer vein, also undivided, is the 'mediastinal' (*m*). The third and much larger vein is the 'humeral' (*h*), sometimes called the 'sub-costal.' It gives rise to several large branches, the subdivisions of which form the framework of the greater part of the wing-cover. The larger of these branches (*d*) is known as the 'discoidal vein,' its branches being designated as (*d'*, *d''*), etc. The fourth or 'median vein' (*n*) is much smaller and soon divides into branches of nearly equal size. Above or behind the median vein is sometimes present a short, undivided vein (*i*), known as the 'intercalary vein.' Next in order is the 'ulnar vein' (*u*), which gives off several branches (*u'*, *u''*, etc.). The upper division of this vein (*o*) is known as the 'posterior ulnar' or the 'sub-median vein.' Close to and parallel with it near the upper or hind margin of the wing-cover is the undivided 'anal vein' (*a*); while the uppermost vein of the wing-cover, also undivided, is the 'axillary vein' (*x*).

"The tegmina are divided by these veins into three areas: the 'costal' or 'marginal area' (M) forms the lower or front edge of the wing-cover and is bounded above and behind by the humeral vein. The 'median' or 'discoidal area' (D) is much the largest and lies between the humeral and posterior ulnar veins. The 'anal' or 'dorsal area' (X) is the free margin lying along the back above and behind the anal vein" (Blatchley).

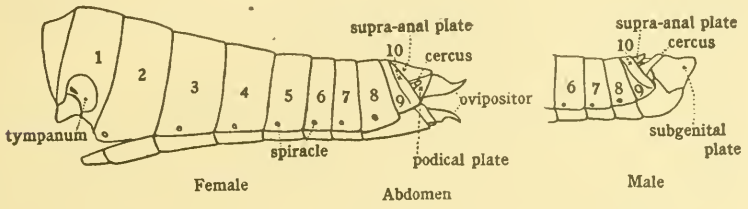
The venation of the tegmina and wings varies characteristically in different families, genera, and sometimes even species of Orthoptera, though showing the same fundamental plan. The names applied to the veins differ widely and the student is referred for fuller information to the works on special families or lesser groups. Diagrams of the venation of Gryllidae and Blattidae are given in this Manual under the headings of those families.

Abdomen.

This (Figs. 16, 17) is elongate, tapering posteriorly, and plainly shows in its middle portion the successive segments of which it is made up, as previously described. The tergum of the first segment is widely separated by the bases of the hind legs from its corresponding sternum, which consists of a broad transverse plate extending between the hind legs and having an anterior lobe

projecting or dove-tailed between the lateral portions of the metasternum.

The tergum is rigidly joined to the metanotum. On each side, near the lower end, is a large crescentic opening lined at the bottom by a delicate whitish membrane, the *tympanum*, which is believed to be part of an organ capable of perceiving sounds. Near its front margin may be seen a tiny opening, the spiracle of the first abdominal segment. Other spiracles may be seen near the lower margins of the terga of the second to eighth segments inclusive.



16 17

Fig. 16.—Side view of abdomen of female Locust. Enlarged. (Original.)
Fig. 17.—Side view of end of abdomen of male Locust. Enlarged. (Original.)

The apical portion of the abdomen differs characteristically according to the sex. If a sufficient number of examples be examined, some will be found (the larger ones) in which it ends in four sharp, slightly recurved horny points, two dorsal, two ventral,—the upper and lower blades or *valves* of the ovipositor of the female. The exact shape of these valves varies specifically and is frequently useful in diagnosis. They may be found lying very closely together, the abdomen tapering to a point; or the tips of the dorsal may be widely separated from those of the ventral pair, even to an angle of 150°. In egg-laying, the tips are repeatedly forced into the ground and spread apart, opening a cavity to a depth sometimes considerably exceeding the usual length of the abdomen. In this cavity the eggs are deposited. By this means the Sprinkled Locust customarily excavates its egg-cavities even in wood, usually soft pine it is true, or that which is partially decayed.

The sternum of the ninth segment is considerably longer than its corresponding tergum, and is the last ventral segment visible

in the female. It ends in a slender, upturned process termed the egg-guide, which lies between the ventral valves of the ovipositor. The ninth and tenth terga are very short and fused together. They are marked by a deep transverse suture except on the lateral margins. Behind them dorsally is a median, convex, somewhat triangular *supra-anal* or *suranal plate.* This covers the dorsal edges of a pair of *podical plates* whose ventral margins are continuous with those of the fused ninth and tenth tergites. Inserted in the sutures between the bases of the podical plates and the tenth tergite is a pair of small elongate-triangular appendages with free tips, the *cerci* (singular *cercus*). These and the valves of the ovipositor are regarded as true appendages of the abdomen, homologous with the legs.

The male is the smaller in size and its abdomen is of a quite different form and somewhat upturned apically. The eighth sternum is no longer than the lower margin of its corresponding tergum; the ninth sternum is large, extending beyond the tenth tergum, and bears apically a large, bluntly conical *subgenital plate,* which terminates the abdomen. The membrane covering its dorsal part is called the *pallium.* The ninth and tenth terga are similar to those of the female. The supra-anal plate is acute at apex and bears midway of its length a prominent sinuate transverse carina; the cerci are a little longer than in the female. In some Locusts the hind margin of the tenth tergum of the male bears in the middle a backwardly directed forked projection or process, the *furcula;* in others this may be reduced to a pair of tubercles on the hind margin of the tergum or entirely lacking as in this species under discussion. The form of the various parts at the end of the abdomen, particularly of the cerci, supra-anal and subgenital plates, is often of great value in distinguishing species (see Plate 22).

Internal Anatomy.

The internal anatomy of the Orthoptera is relatively of so little importance to persons interested simply in their natural history that it may be passed over here very briefly. It is in general similar to that of other types of insects. The food-canal extends from mouth to anus, its parts varied in accordance with the work they have to perform: the grinding of the food is done

not only by the jaws and maxillae but by chitinous teeth or ridges in the walls of the gizzard (*proventriculus*); digestion and absorption take place in the middle part of its course. Between the outer tube formed by the body-wall and the inner tube of the food-canal lie the other internal structures,—muscles, nerves, glands, and reproductive organs—in a cavity filled with blood, which is kept in motion by the pulsations of a cylindrical heart lying in the dorsal part of the abdomen. Immersed in a circulating nutrient fluid, special blood-vessels to the various organs are unnecessary. The needs of respiration are supplied by a system of air-tubes (*tracheae*) opening externally at the spiracles and penetrating every part of the body and its appendages. These have a characteristic appearance under the microscope owing to the spiral or ring-like chitinous thickenings in their walls which hold them open, like the wire in suction hose. In Locusts, large air-sacs in addition serve as reservoirs in the body and connect with the tracheae near the spiracles. The lining of the tracheae, and also of portions of the food-canal, is shed at the periodical molts.

For a full account of the internal anatomy the reader is referred to the works cited in the text under the several groups.

Habits.

With the dawn of consciousness the young orthopteron finds itself in circumstances almost as varied as the species, according to the location of the egg. The parent Earwig and Mole-cricket deposit their eggs in underground chambers excavated by themselves, and are credited with helping the young to emerge and even with taking care of them for some time afterward. But for the most part survival and success in life are entirely dependent on the actions of the tiny, new-born individuals themselves. The eggs of Walking-sticks lie all winter long, seed-like, among the fallen leaves of woodlands; some, it is believed, for two winters. The young hatch in spring, clamber up the stems of the undergrowth, and feed on the newly sprouting, tender leaves. The eggs of Roaches are encased in horny capsules, several in each, which are dropped at random in the haunts of the parent. Those of the Katydid are gummed to the twigs of trees frequented by

the parents and the young may not descend to earth during their entire life, till the frosts of autumn or the exhaustion of old age paralyze and kill. The eggs of Meadow-grasshoppers and Coneheads are placed in security deep in the leaf-sheaths of grasses, or enclosed in galls, leaves, or other vegetal tissue. Those of Field-crickets and most Locusts are embedded in the earth, singly or in masses, in wet or dry soil according to the species; those of Tree-crickets and certain Locusts are placed in cavities bored in pithy stems or even solid wood by the parent, in holes in trees made by other insects, or beneath the bark of decayed trees and stumps.

With all these varied locations of the egg, it is evident that the conditions surrounding and affecting the young insect at hatching differ widely. It is impossible to treat here of all. As an illustrative example let us select a typical Locust or "Grasshopper"

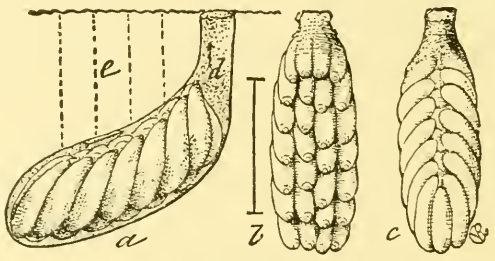


FIG. 18.—Egg-mass of Locust; enlarged. *a*, from the side, in burrow; *b*, from beneath; *c*, from above. (After Riley.)

which has been thoroughly studied, such as the Rocky Mountain Locust (*Melanoplus spretus*) a near relative and regarded by some as a variety of our common Lesser Locust (*M. m. atlanis*). In this species the female excavates by means of her ovipositor a cavity an inch or more deep in firm, rather dry soil. Having reached a depth governed by the length of the abdomen when extended to its utmost, the Locust lays the eggs one by one in an ovoid mass, accompanied by a quantity of frothy mucous fluid which soon hardens, binding them together and to some extent protecting them from injury by moisture. These masses or 'pods' contain from 25 to 35 eggs each and several are laid by each female, at intervals of a few days. The upper end of the mass terminates in a smaller neck of the frothy material, which fills the cavity to

the surface of the ground. This provides an easily excavated pathway by which the tender, newly hatched larvae can struggle to the surface.

The eggs are cylindrical, tapering to rounded ends, and a little curved, the concave side being ventral in position. They are arranged in the mass with a considerable degree of regularity in about four longitudinal rows, and are placed somewhat obliquely, the head end of the embryo being highest and nearest the pathway of escape. At hatching-time the weakened egg-shell bursts under the struggles of the enclosed larva, and splits along the ventral side. The larva (or *nymph*), enclosed in a thin pellicle (*amnion*), works its way out of the egg-shell by a series of undulatory movements, and along the pathway provided by the neck of the egg-pod, which offers but little resistance, or even directly through the earth if not too firm, upward to the surface of the ground. Here the pellicle is quickly ruptured by its struggles, cast off, and left behind as a white, crumpled shred of tissue which has served as a protection during the escape of the larva from the soil.

The newly hatched insect is pale and colorless but soon darkens, becoming mottled with gray and brown. It differs from the parent in size, in the total lack of wings, and somewhat in the proportions of the head and body, but is at once distinguishable as a Locust. Its growth to the adult state is accomplished by a series of steps or stages during which it feeds voraciously. These stages are separated by periodic molts of the chitinous exoskeleton which is too inelastic to permit of growth and must be got rid of. At the time of molting, it increases rapidly in size before the body-wall becomes rigid. At each molt there is also a decided increase in the size of the developing wings and tegmina. The size and form of these serve admirably to distinguish the various stages, of which there are five, the series closing with the sixth stage or adult form, which the insect retains till death.

In the first stage not even the rudiments of tegmina and wings can be seen. After the first molt a slight enlargement of the posterior ventral angles of the mesonotum and metanotum may be noticed. This increases with the second molt so that a considerable prolongation downward and backward of these angles is evident in the third stage. In the fourth stage the rudiments of

both tegmina and wings are unmistakable, the latter as somewhat triangular pads, upraised, with the anterior margin of the wing dorsal in position, and enclosing between them and the sides of

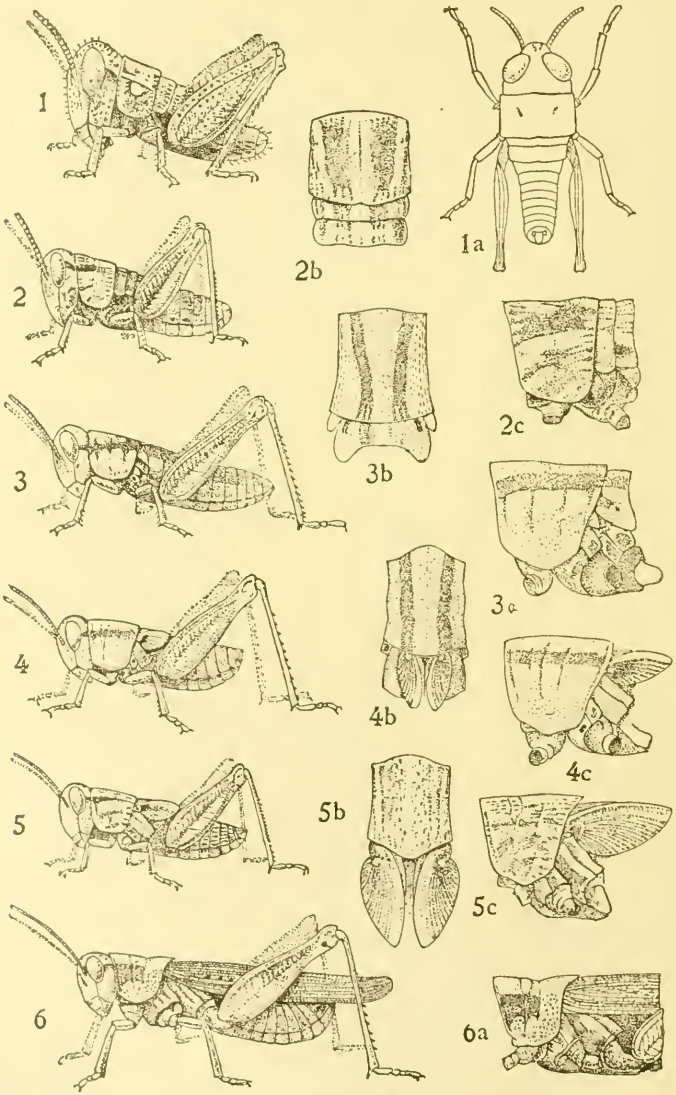


Fig. 19.—Development of Red-legged Locust (*Melanoplus femur-rubrum*) showing five nymph stages and growth of wings. (After Packard.)

the body the narrow wing-covers to be. In the fifth stage the body of the young is about as large as that of the adult, and the wing and tegminal pads are conspicuous and nearly as long as the pronotum. They are still reversed in position, that is, the wing-pads overlie the tegmina, furnishing a ready means of distinguishing an immature winged Locust, Grasshopper, or Cricket from an adult short-winged species.

With the next molt (fifth) the wings and tegmina develop fully, if ever; the insect becomes sexually mature, and the activities associated only with adult life (stridulation, mating, oviposition) begin.

It will be evident from this account that there is no quiescent non-feeding pupal stage in the life history of these insects, and no great change, transformation in form, or metamorphosis, such as characterizes the development of a butterfly, beetle, wasp, or fly. However, insects of this order in the stage preceding the adult, with conspicuous wing-pads, are often referred to, especially in the older literature, as *pupae*. A modern term, applicable to all stages of the young of those insects exhibiting a direct development with no quiescent pupal stage, is *nymph*. This may be used for all stages of young Orthoptera.

The final molt in passing from the fifth nymph stage to the adult condition, with the acquisition of fully developed wings and tegmina, is of special interest and may be readily seen by catching young examples and watching them in captivity. When about to molt the nymph takes its place on some weed, grass-stem, or suitable object, usually head downward and held in position by the hind feet, with the shanks doubled upon the thighs. Shortly, the skin splits open in the dorsal mid-line and from the rent slowly emerges the head and thorax, presently the antennae, front and middle legs, and at length the abdomen and long hind legs, the shanks of the latter being drawn, while in a soft and pliable condition, past the bent hind knees. This accomplished, the pale and flabby creature turns around, climbs up on its cast-off skin, and rests while the pendant wings expand and the whole body stiffens and gains strength. The act of molting requires from half an hour to an hour, and the subsequent drying and hardening process a like amount of time. It is said to take place most often in the warm and moist hours of the morning. The

cast-off skins (*exuviae*) are common objects in grassy fields in midsummer, looking like pale ghosts of Grasshoppers, the sides of the mid-dorsal rent through which the adult escaped having closed nearly to their original position.

The primal need of the young Locust is food; its principal activity is eating. Its function in the scheme of Nature is to convert the grass and herbage of the fields into animal tissue. During or at the end of its part in this process it is likely in turn to serve as food for other organisms, either higher or lower in the scale of existence (see *Enemies*).

The process of food-getting is carried on continually during suitable weather, with brief periods for rest, molting, and perpetuation of the species, from birth to death. Some species are particular in diet but most of them are general feeders, insistent on quantity rather than quality, and eating the foliage of a wide variety of plants. Water is secured in part from the plant tissue consumed, but also in additional amounts, if needed, from dew and rain-drops. Like other New Englanders our resident Orthoptera are at the mercy of the weather and perforce must adapt themselves to its vagaries. As a group they relish heat, and a majority prefer drought to dampness, preferences which they exhibit by certain readily observable habits.

In early spring when nights are cold and the ground, sun-warmed during the day, gives out stored heat at night, over-wintering species like the Green-striped, Spring Yellow-wing, and Coral-wing Locusts creep for warmth and protection during the cold night hours beneath tufts of grass, fallen leaves, or into crevices of the earth. In late summer, in salt-marshes and other wet places, I have seen hundreds of young Red-legged Locusts gathered to spend the night on the stems of grasses and other plants a foot or more above the wet and cold ground. At all times of the year they sun themselves when opportunity offers, but particularly after rain or near the end of the season. On Block Island, ten miles at sea, I once saw them massed in clusters on the sunset side of stone-walls and fences, basking in the declining rays while the air grew chill. In this way the warmth stored during the day in the blocks of stone was utilized by them to pass the night in greater comfort.

When breeding-places become over-populated and food fails,

the young are forced by hunger to travel outward in search of fresh supplies. As numerous and irresistible as a conquering army they march onward, devouring everything edible. Even growing shoots and the tender bark of trees and shrubs are eaten, and the weather-beaten fibers on the surface of boards, fences, and buildings are scraped off by their horny jaws, exposing the new, solid wood. Under such circumstances a migratory instinct develops in some species, even in the wingless young, and they press onward blindly, plunging recklessly into streams, where they form masses of struggling insects clambering over and over each other as they are swept downward by the current to be drowned, eaten by fishes, or perchance to be cast ashore on either bank and continue their depredations. On reaching maturity, they gather in swarms which darken the air and migrate for hundreds of miles, carrying destruction to the districts they invade and becoming one of the scourges of the earth. Singularly enough, the young which hatch from the eggs laid in the ravaged territory, which is often unsuited for permanent occupancy by the species by reason of climatic conditions, are said to show a tendency to make a return migration in the direction of the land of their progenitors.

A vivid picture of a serious outbreak here in New England in the early part of the last century is on record and is quoted on pages 265.

Courtship.

Arrived at maturity, activities connected simply with the welfare of the individual become subordinated to those concerned with the perpetuation of the race. Flight is now possible for most species, at least for the males, and they seek the presence of the other sex, often traveling far in the search. Nocturnal species frequently respond to the attraction of artificial lights; winged Roaches, Crickets, and Pygmy Locusts occasionally come in swarms to street lamps and brilliantly lighted windows, in some cases undoubtedly flying for miles. At this time also special evolutions during flight are characteristic of many Band-winged Locusts (Oedipodinae); the so-called courtship dance of the Carolina Locust is perhaps best known. This I have often seen and I can fully subscribe to the statements in

the following graphic description by Townsend, as quoted, with subjoined comment, by Scudder (23d Rept. Ent. Soc. Ontario, 1892, p. 77):—

"On the 14th of August last, in the afternoon, I saw one of this species fly up from the dry parched grass, and remain nearly stationary about two feet in the air for some time, by means of a rapid beating of the wings. Presently it flew back to the ground. In a few minutes another one, which had witnessed the performance at a short distance, flew quickly over and alighted by the side of the performer. They ran by each other several times, occasionally touching each other, but did not make any other manifestations, and finally the last one flew away, leaving the other motionless in the withered grass. Though it is probable that the females are attracted by these performances of the males, and that the males vie with each other in their exhibitions, still I think that the two just spoken of were both males, and were disposed to fight from a feeling of rivalry, the one that flew off having been beaten.

"On the 24th of the month I noticed the same thing over again. An individual performed three times in succession, and then another alighted on the ground by its side; they ran by each other several times, apparently clasping, probably in conflict, for I am quite sure that they were both males. At last one of them flew away, and the other soon after renewed the performing. I regret to say that I did not capture specimens to ascertain the sex; but, judging from size, I do not think I have seen any but the males taking active part in the aerial exhibitions. In going through with the performance they rise at first generally about three or four feet, making a light purring or beating sound, and then, rising higher, change the motion of the wings, when a curious, sharp, see-sawing sound is produced. Some rise even higher than six feet in the last act; others rise only one or two feet. Of course some excel others in the beauty and ease with which they accomplish the feat; many do not remain in just the same place while hovering, but vary, falling or jerking about while endeavoring to keep the same point in the air. I am of the opinion that the females are sensitive to the grace with which this is performed." —(Townsend).

"I have repeatedly witnessed this ascent from a single spot, and

hovering thereover so well described above, during which an interrupted crackling sound is produced, evidently at will, with particular movements of the wings, but the sound is a muffled one, though decidedly louder and sharper than that heard during its ordinary flight. I have seen it rise to a height of ten feet, particularly when in face of a bank, and it often remains a considerable time in the air nearly stationary or moving slightly up and down."—(S. H. S.)

This account brings us logically to a consideration of the subject of the noises made by these insects, their purpose and place in Nature, and the methods by which they are produced, a subject of more than usual popular interest.

The Songs of Grasshoppers and Crickets.

"I have reflected with surprise on the diversity of the means for producing music with insects, and still more with birds. We thus get a high idea of the importance of song in the animal kingdom."—Darwin.

In spring-time the fields and woods resound to the voices of amphibians,—frogs, toads, and their like,—sitting up to their necks in ice-water it may be, but jingling, croaking, or trilling merrily, nevertheless, telling us that Nature has again set free the streams and ponds; and to the songs of birds also, which thrill us even more with the kindred sympathies and emotions which we share with them at nest-building time.

In midsummer the songs of these children of Nature gradually die out and are replaced by others of different origin—insect voices—to which the golden days of autumn slip by as to an unceasing accompaniment. Night and day shifts of performers, with talent diversified according to the locality and the environment, provide a constant undertone of varied sounds,—sounds which are appreciated by but few and scarcely noticed by the many human creatures to whom, next to the insects' mates, they should most strongly appeal.

"It sounds like fall," is a remark frequently heard in the latter days of August; but exactly why is scarcely given a thought. Beyond a general but vague impression that Crickets are in some way responsible, few hearers have any idea of the variety of

musicians, of their melodies, or of the methods by which they are produced. Indeed, some human ears are normally unable to perceive the exceedingly tenuous sounds produced by many of these insects.

When the warm twilight falls in late August or September, hushing the noises of daylight, everyone becomes aware of insistent murmurs from thicket and copse. Scarcely less numerous in favorable localities, though less noticed owing to the greater variety of distractions, are those of the day-time, voices which are often submerged in the volume of other sound. In the fields, the sunny autumn days are enlivened less by the plaintive calls of southward-flying birds than by the constant chirping, buzz, and rattle of myriads of insignificant creatures filled for a brief period with the literal sunshine of life and making music their steadfast pursuit.

Then, the rambler's steps are accompanied by the notes of humble little creatures into whose haunts he has unwittingly intruded; and if he is keen to learn the why and wherefore of Nature's ways, he discovers that the minor-keyed music of autumn days and nights is sounded on the miniature violins of Crickets, Grasshoppers, Katydids, and Locusts. For it is to this lowly type of life that we are indebted for the vocalization of the spirit of the dying year; an expression of joy to them, it may be, but to us a prophecy of the end. In poetry and in prose many passages attest the important part their music plays to sensitive minds in expressing the heyday of midsummer life and the undefinable melancholy of autumn. The influence of these sounds upon the human mind varies with the individual, with the season, and with the song. And the song of the same singer varies likewise. It may be filled with the throbbing intensity of summer,—a passionate call of life and love at the height of activity of the insect,—or a feeble note of cheer to comrade mates and minstrels before passing into the oblivion of winter. The relation of these songs to human life lies more properly, however, in the field of the student of human psychology. It is our wish to learn how the sounds are produced and their significance in the life of the insect.

Insects produce sound in a variety of ways. The motion of the wings causes whispering, rustling, buzzing, or humming sounds, varying largely with the speed of movement. This is

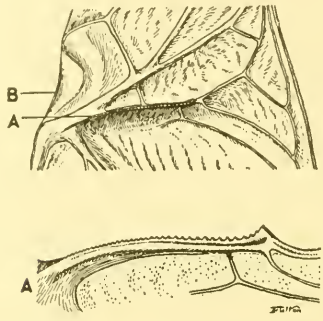
characteristic of most flying species but is not to be regarded as purposeful sound production. Sometimes a high-pitched piping note is sounded by bees and flies by the vibration of membranes at the openings of the spiracles when acted on by a current of air,—a type of sound thus akin to our own voices. The cicada produces his shrill *zee*-ing or buzzing notes by vibrating a tense membrane by means of powerful muscles working on the principle of the 'devil's fiddle.'

In by far the larger proportion of cases, however, insect sounds are produced by stridulation, a rubbing of one part of the body on another. As might be expected in creatures of such varied and complicated structure there are wide differences in the details of its production with reference to the parts of the body involved, and in the quality of the sound produced.

Among our New England Orthoptera sound is produced, as a rule, only by the adult male, though the female sometimes makes it in lesser degree. Since both sexes are equipped with auditory organs and respond to the sound produced, it is presumably useful as a means of communication, and especially of attraction of the female by the male. Males often stridulate, however, apparently in rivalry, in play, or from the mere joy of living, after pairing has been completed; and occasionally the sound produced is used defensively when attacked, *e. g.*, in the cases of the Katydid (*Pterophylla camellifolia*) and the southern Lubber Grasshopper (*Rhomalea*) which respectively squawk and hiss when touched or about to be seized.

The chief methods of sound production among Orthoptera are three in number: 1st, by rubbing certain parts of the bases of the wing-covers together,—this is the method used by the Crickets, Katydids, and Long-horned Grasshoppers; 2d, by rubbing the hind thighs against the closed wing-covers,—this is done by some kinds of Locusts; 3d, by beating the wing-covers with the front edge of the wings while flying,—this method also is characteristic of some kinds of Locusts, the Oedipodinae particularly, and in many cases the two latter methods are used by the same insect. It is not unlikely that marked variations of these, or even additional methods, are employed in some cases by our New England species, as is known to be true of some exotic Orthoptera.

First Method.—If the wing-cover of a male of our common large Field-cricket (*Gryllus*) be examined from above there will be noticed near the base a strong, depressed transverse vein. On the under surface of the wing-cover the vein projects as a conspicuous raised bar and bears a continuous row of very fine, transverse, file-like, sharp-pointed teeth projecting downward and inward (toward median line). At the end of the vein, between it and the inner margin of the wing-cover, is a tuft of short hairs; in front of these (nearer the base) is a crescentic transparent spot whose outer edge is faintly concave, forms a



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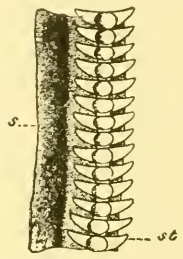

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Fig. 20.—Portion of tegmen of Broad-winged Tree-cricket (*Oecanthus latipennis*), showing file (*A*) and scraper (*B*) used in sound production. (After Fulton.)

Fig. 21.—Stridulating teeth on tegmen of House Cricket (*Gryllus domesticus*). (After Landois.)

part of the inner edge of the wing-cover, and is slightly browned by a heavier deposit of chitin or pigment. This edge forms a sharp scraper which rasps on the teeth of the underside of the other wing-cover, setting both tegmina into vibration and producing the characteristic chirp. Usually the right tegmen overlaps the left, but each bears a file and scraper and they can perhaps be used interchangeably in stridulation,—or possibly there are right- and left-handed Crickets! In the Bush-katydids (*Scudderia*) the left tegmen overlaps the right, its scraper is apparently lacking, and the file on its under surface is much better developed than on the right tegmen. The file with its row of teeth may be readily seen under the compound microscope in surface view, and the teeth show especially well when mounted in profile. When about to stridulate, the Cricket elevates the

tegmina to a high angle with the body, adjusts them at an angle with each other in position to bring the scraper to bear on the file, and sounds his call.

Second Method.—If the hind thigh of a male of almost any of our Acridine (Tryxaline) Locusts (except *Mecostethus*) be examined, there will be noticed on the basal half of the inner side a prominent ridge and projecting from it a row of very fine, short, erect, peg-like teeth, developed, it is probable, from modified hairs. These are usually more thickly set toward the base of the femur, and sometimes are scatteringly placed toward the end of the row. They vary much in number with the species, sometimes forming a long, close-set series as in *Pseudopomala*, sometimes a short and irregular one. They are present in the female of *Chloealtis conspersa* in a less developed condition,—at least in some individuals.

When the femora are raised vertically and at the same time pressed inward, these teeth rub against certain prominent veins of the wing-covers and cause them to vibrate, producing a faint scritching sound, sometimes loud enough to be heard at a distance of several feet. In *Mecostethus* and most Oedipodinae these peg-like teeth are absent from the hind femora but their place is taken by tooth-like prominences borne on the tegminal veins, especially on one (mediastinal) which is undeveloped in most of the Tryxaline series of Locusts. The call of *Mecostethus gracilis*, in which they are exceptionally well developed, is audible at a distance of fifty feet or more.

Third Method.—In addition to the foregoing, the Oedipodinae usually have the ability to make distinct crepitating, rattling, or even snapping sounds during flight. Just how these are produced is perhaps open to question. They are generally said to be due to rapid blows on the tegmina by the stiff front margin of the wings. Several possibilities have been suggested and it still remains for some ingenious person to determine the exact procedure. So loud is the noise produced in this way by some species in the Far West that it may be heard at a distance of a quarter of a mile. The Broad-winged or Snapping Locust, the most skilled in this method of any New England species, is able to sound either a continuous rattle or separate loud snaps or clacks at will, while in flight or during airy evolutions given in

rivalry with his male companions. (See p. 234, *Courtship of the Carolina Locust.*)

It is evident that in all of these methods the sound is produced by vibrations of the tegmina set up by the friction of the hind femora or impact of the wings. Sometimes the tegmina serve not only as sounding-boards but also by great concavity of shape form a resonating chamber, as in the Katydid (*Pterophylla*).

Stridulation while at rest may be readily witnessed in the field by using due caution in approach, and artificial light by night (of which the insects seem not to be afraid). They are sensitive to sudden movements and to the jar of footfalls, etc. If startled they may often be induced to recommence their song by the judicious use of a file and a quill or similar contrivance for imitating the sounds, approaching more closely after confidence has been restored. Or they may be watched at ease by capturing several of both sexes and keeping them in captivity with a supply of food and water. Single males perform well at times but the stimulus of companionship is usually productive of greater activity.

A word of caution may not be amiss. When making observations it is important to be absolutely sure of the identity of the insect musician (many errors are embalmed even in scientific literature), and to consider carefully the acoustic conditions of the spot where the sound is produced,—the song of the same Tree-cricket trilling high in air above one's head sounds faint and far away compared with its effect when given close to the ground and reflected toward the listener by an amphitheater of bushes. But it is an interesting pastime to follow in warm autumn days and the acquaintance of these little minstrels is well worth the effort necessary to secure it.

The following papers on the subject of stridulation will be found helpful and suggestive, those by Scudder being the earliest in point of publication, Allard's the latest. In addition, many notes will be found in the writings of Davis, Fulton, Rehn and Hebard, and others on particular groups or species.

Allard, H. A.—"Musical Crickets and Locusts in north Georgia." Proc. Ent. Soc. Wash., vol. 12, p. 32–43 (1910).

"Some New England Orthoptera observed in late October." Ent. News, vol. 21, p. 352–357 (1910).

"Stridulations of some Katydids." Proc. Biol. Soc. Wash., vol. 23, p. 35–40 (1910).

"Stridulations of some Cone-headed Grasshoppers." Proc. Ent. Soc. Wash., vol. 12, p. 121–124 (1910).

"Musical habits of some New England Orthoptera in September." Ent. News, vol. 22, p. 28–39 (1911).

"Xiphidion stridulations." Proc. Ent. Soc. Wash., vol. 13, p. 84–87 (1911).

Morse, A. P.—"Some notes on Locust stridulation." Journ. N. Y. Ent. Soc., vol. 4, p. 16–20 (1896).

Scudder, S. H.—"The songs of the Grasshoppers." Amer. Nat., vol. 2, p. 113–120 (1868).

"Notes on the stridulation of some New England Orthoptera." Proc. Boston Soc. Nat. Hist., vol. 11, p. 3–8 (1868).

"The songs of our Grasshoppers and Crickets." 23d Ann. Rept. Ent. Soc. Ontario, p. 62–78 (1892).

"Many kyndes of voyces are in the world, ande none off them without signification."—Tyndall's transl., 1 Cor. xiv: 10.

Coloration of Orthoptera.

Color, as used by the biologist, refers to a single hue. Relatively few animals exhibit one color only; most of them, insects as well as others, bear a more or less definite pattern, arrangement, or combination of colors and the entire combination is referred to as their coloration.

The colors of insects are divided into three classes: 1, *structural*, or physical, caused by reflection or refraction of light rays by the structure of the parts exhibiting them; 2, *pigmental*, or chemical, due to the composition of certain internal substances on which the color depends, termed pigments; and 3, *combination*, or physico-chemical, colors produced by a combination of both means. The Orthoptera present examples of all three classes of colors; their general coloration, however, is mainly dependent on those of the second and third classes.

Structural colors are often well shown by iridescence of the wing-membranes in clear-winged species, notably the Acrydiinae (Tettiginae), some of the Melanopli, and Meadow-grasshoppers. They are here due to interference effects of the light rays from the two very thin, closely placed membranes which make up the wing surface. Violet, blue, silvery white, and green are often structural colors, but white and green pigments are also common.

The majority of the colors exhibited by Orthoptera are pigmentary in character. They lie in the outer (cuticula) or inner (hypodermis) layer of the integument, or in both, and affect each other. The development of the pigment depends in part on exposure to light and oxygen, as shown by the gradual darkening of a newly molted insect. Sometimes the cells of the hypodermis contain colored granules or oil drops which give red, white, or yellow effects from the exterior; sometimes they contain diffused chlorophyll (green) or xanthophyll (yellow) pigment derived from the food plant. Some pigments are known to be excretory products.

Colors which resemble the usual background are said to be sympathetic; others, non-sympathetic. Good examples of sympathetic coloration are shown by the green and the brown phases of the Bicolored Locust (*Dichromorpha viridis*) and Green-striped Locust (*Chortophaga viridifasciata*), the green resembling the hue of living, the brown that of dead vegetation of the fields in which they live and against which they are seen. In the Salt-marsh Locust (*Orphulella olivacea*) an olive tint is developed in both phases harmonizing with that of the salt-marsh vegetation.

The Orthoptera as a whole have received less investigation as regards color than some of the more brilliantly clad insects, and only certain elementary and general statements can be made regarding them. The usual brown or black hue of Earwigs, Roaches, terrestrial Crickets, and Cave-crickets probably has no especial biological significance. It is a color generally developed in chitin (the chief element of the body-wall) after exposure to light and air. In habits these Orthoptera are typically nocturnal and live in burrows, crevices, or cavities; these colors suit the circumstances well and are protective to a considerable degree, but probably should not be classed as purely sympathetic.

The coloration of Walking-sticks, Tree-crickets, Katydids, Cone-heads, and Meadow-grasshoppers is obviously sympathetic and protective. They are exposed during the day when their foes are most active, and their coloring protects them from observation among the green leaves or the gray and brown twigs of their haunts. Probably that of the Shield-backed Grasshoppers (*Atlanticus*) also, though differing widely, should be

regarded as sympathetic, since these creatures, though chiefly nocturnal, often live among brown fallen leaves.

The Locusts (Acrididae) present a wide variety of hues and require consideration more at length. With reference to coloration, a Locust presents three classes of surface: 1st, the ventral part of the body next its support of earth or plant,—this is shielded to a great extent from external influences such as the action of light and the observation of birds and other enemies; 2d, those parts continually exposed, day and night, at rest and in action, to light and observation, comprising the dorsal, lateral, anterior and posterior surfaces; 3d, those parts exposed only occasionally, and usually for brief periods only, during attack, courtship, or other exciting circumstances, or while in rapid motion, comprising the wings, hind tibiae, inner and under sides of the hind femora, and sides of the base of the abdomen.

The coloration of each of these surfaces needs to be studied in correlation with that of the others and with direct observations on the habits and distribution of the insects in the field. That of the first class of surfaces (ventral part of the body) has received scant attention, much less than it deserves. A very large proportion of animals, Locusts among them, exhibit the phenomenon of "counter-shading." In this type of coloration the ventral side of the body is paler and less varied in tint than the dorsal, and this paleness serves to offset the intensity of light received from above and efface the solidity of the animal through diminution of the shadow due to its roundness. The paleness is due primarily to lack of exposure to light and consequent slight development of pigment on that part of the body; it is secondarily protective in function as it helps in the majority of vertebrates and many invertebrates to obliterate the form of the body. While most Locusts exhibit counter-shading in some measure, there are a few conspicuous exceptions in New England, particularly the species of *Arphia*, and to a less extent *Encoptolophus*, in which the ventral surface is black or very dark. Possibly this is to be explained by the form of the body of a Locust as contrasted with that of most vertebrates,—triangular in vertical cross-section, the base placed on the ground,—and the habit which these insects have of resting directly on a dark soil, thereby effectively shutting off light from below or beyond, which would bring them into relief.

The coloration of the second class of surfaces (dorsal, lateral, etc.) is, with few exceptions, highly sympathetic in character, harmonizing with or resembling very closely, often to a marvelous degree, the background of the insect's environment. Earth tints, rock and sand textures, the infinitely varied browns, greens, and grays of living and dead vegetation, yellow, orange, rose, and silvery white are all represented in spots and streaks, the effect being to merge the insect indistinguishably into its background while at rest, thus shielding it in a very high degree from the observation of its foes. These colors are of great protective value at the present time, natural selection continually acting to preserve and perfect them, but though highly protective in character, they are without doubt primarily due to physiological processes and influences as yet imperfectly understood.

This type of coloration is admirably illustrated among New England species by the Seaside Locust and Sand Locust which live on sandy backgrounds, the Snapping and the Ledge-loving Locusts on rock habitats, the Coral-winged and the Clear-winged Locusts in fields; and in the plant-perching species the Pine-tree Locust with its background of lichened pine bark, the Red-legged and the Two-striped Locusts among the yellowish green of herbage, and other species of *Melanoplus*,—*M. mancus*, *M. fasciatus*, etc.,—whose darker tints resemble those of fallen leaves from the Vaccinium thickets amid which they live.

One who has not watched these creatures out of doors can appreciate to but a slight degree the effectiveness of sympathetic coloring as a means of concealment. Let him but try to pick out from its background immobile grass-green Cone-head, leaf-brown Shield-backed Grasshopper, or any of the Locusts just mentioned, and he will realize as never before the importance to the defenceless insect of Mother Nature's protective mantle of invisibility.

The colors of the third class of surfaces (parts exposed occasionally), are on the contrary, in many cases non-sympathetic in character to a high degree; they are often bright and strongly contrasted, striking in effect and at times exceedingly conspicuous. This is very generally the case among the North American Oedipodinae and certain Locustinae (Acridinae), and is well illustrated among our New England Locusts by the species of

Arphia, Dissosteira, Scirtetica, Spharagemon, Pardalophora, and *Circotettix.* What is the function, the significance of these colors, in these hidden places, seen only in flight or when especially displayed? Let us consider the color of the wings first.

Some authors have explained the presence of striking colors and patterns on the wings of Orthoptera, which are concealed when at rest, as due to what they term 'contrast-mimicry' and primarily of value as a means of dazzling or confusing a pursuer by their sudden appearance and disappearance during flight and at its termination. In North American species at least these colors are usually exposed continuously during flight, though disappearing abruptly at its close. However, such an explanation is a needless tax upon the imagination. There is a much simpler one which is almost forced upon the mind of the stroller in the fields, and which may be readily observed by taking a favorable position in a station thickly populated with adult *Trimerotropis, Arphia, Spharagemon,* and other similarly ornamented Oedipodinae.

The flight of one of these Locusts attracts attention not alone by its display of color but by its crackling character; the conspicuous wing colors, red, yellow, or black, often in strong contrast, render its flight easy to follow, as it is very frequently followed, by others, which drop to the ground in close proximity to it. There can be no doubt in the mind of one who has watched these actions repeated over and over again, of the value of these colors as a means of signaling, of attracting attention, and thereby effecting or maintaining communication between the sexes or the individuals of a community. These wing colors are also frequently displayed during courtship, while the insect is at rest upon the ground or a suitable perch, and even when attacked by enemies, as I have observed in some instances.

The colors of the hind tibiae and inner sides of the hind femora, though often bright, are too limited in extent of surface to be of use as a signal during flight. They are entirely hidden when the insect is at rest, but come into view while it is walking and during the stridulatory movements of the hind legs which most Acrididae practice in mating-time. These conspicuous non-sympathetic colors and markings, displayed only at such times, seem to possess, therefore, a special significance in relation to this period in the

life history of the insect. The wing and tibial colors differ much, not only specifically but also individually in the same species, frequently varying, on the tibiae, from clear yellow to red, sometimes deeply infuscated, or from red through yellow and greenish to deep blue; on the wings from pinkish red to yellow and yellowish white. From numerous observations a blue color of the wings and hind tibiae seems to be associated with a certain degree of aridity of climate, a red color with humidity. Probably additional factors are involved.

Since all Locusts are single-brooded in New England there is not the opportunity to develop seasonal phases of coloration, such as frequently occur in butterflies. The nearest approach to anything of the sort is the gradual deepening of tint which takes place during life. This is shown well in old individuals of the Green-striped Locust taken late in the season, particularly of the brown phase, the paler brown tints of the spring having become much darker, even nearly fuscous in places. This effect is doubtless due to a gradual development or deposit of pigment in the cuticular layer with long exposure to light, a phenomenon of age rather than of season. There is probably also a difference of tint in the wings of the Sand Locust during the life of the individual due to a similar increase of yellow or red pigment, but this needs to be investigated. The effect of exposure to low temperature might be called a seasonal phase of coloration. It is shown by *Melanoplus luridus* and *M. femur-rubrum* after several heavy frosts late in the fall; examples taken then exhibit a general duskiness of coloring decidedly at variance with the clear yellow and green tints seen early in the season.

Though individuals of certain species vary enormously in depth of hue, few examples of true albinism or melanism are known; the most striking one which I ever saw was a melanistic example of *Paroxya clavuliger* in which the usual clear yellow and olive tints were supplanted by a greenish black with an oily lustre. "White" Crickets and Cockroaches are of course simply recently molted individuals. Black specimens of the Swamp Locust (*Paroxya clavuliger*) have been captured, and a black form of the Differential Locust (*Melanoplus differentialis*) is locally common in the West. In the South the Lubber Grasshopper (*Rhomalea*) is represented in part of its range by a form almost wholly deep black.

Pink Katydids of the genus *Amblycorypha* are among the most striking of insect freaks. Several examples have been captured, from Massachusetts to Indiana, and attempts have been made to breed from them, as yet with unsatisfactory results. The pink color appears at an early age and persists throughout life. It is probably due to a physiological peculiarity of the individual, the normal green coloring being acted on chemically by some reagent developed in the body of the insect.[1]

Dichromatism, the occurrence of two color phases in the same species, is frequent in Locusts and not uncommon in some Grasshoppers. Typical cases are those of the Green-striped and Bicolored Locusts, in which both sexes may be either brown of varying shades, or green with or without a small amount of brown. In the former species green females and brown males are the rule, and in some parts of the country green males are said to be almost unknown. A possible explanation may be that this species matures in April, at the time the face of the fields changes from the faded browns and grays of winter to the verdurous green of spring-time, that both colors are equally protective, and that males usually mature a little earlier than females. There would therefore be a tendency for a larger proportion of males to be subjected to the influence of brown backgrounds as compared with females, and perhaps in time this character would become inherited by the male sex. On the contrary, Dr. Whiting's experiments (see p. 249) seem to indicate that temperature is more important than light or humidity in its influence on color. He is inclined to think that the color difference in *Chortophaga*, between green and brown at any rate, is strictly genetic and physiological, and does not depend upon light or color of environment. Another experimenter thinks the case is different in certain other genera. The whole matter needs research. The Sword-bearer (*Neoconocephalus ensiger*) and its congeners are frequently brown, cases perhaps analogous to that of the pink Katydid, though it may be pointed out that brown is equally as protective as the normal green.

The presence of an olivaceous suffusion in both phases of the Salt-marsh Locust has already been alluded to. The Salt-

[1] Hancock, J. L. "Pink Katydids and the inheritance of pink coloration." Ent. News, vol. 27, p. 70–82, 1916.

marsh Grasshopper (*Conocephalus spartinae*) and the Dusky-faced Grasshopper (*Orchelimum concinnum*) also exhibit, besides the green form, another of dingy brown. The significance of this coloring in association with a salt-marsh habitat, whether physiological or chemical, remains to be learned.

Whatever the biological significance of the color, coloration, and markings of our Orthoptera may be, it is certain that in many of our species of Locusts it is very variable, so much so as to be practically worthless as a diagnostic character. Sometimes it seems to be connected with the local hue of the background, yet often it is entirely independent of it. Not only are two typical color phases (brown and green) exhibited by the Spotted-winged and Pasture Locusts (*Orphulella pelidna* and *O. speciosa*), but both show much difference in intensity of hue and these colors are encroached upon to various degrees by black markings, while a conspicuous rose-tinted variation combines with either. The result is that rose-red, rusty, brown, green, and black patterns make an almost endless number of color varieties. The Marbled Locust (*Scirtetica marmorata*) in its pale phase is greenish white mottled with black; the larger proportion of individuals, however, are more or less suffused and rather heavily marked with hematite red, a peculiar tint exactly matching the soft dull hue of weathered pitch-pine bark, which is an abundant material in the usual habitat of the insect on pine-clad sandy barrens. Occasionally this hue deepens to a rich wine red. The coloration of this insect thus unites in varying proportions the hues of its backgrounds when at rest,—the pale tints of the exposed rain-washed sand and greenish white Cladonia lichens, and the dark hues of pine bark and decaying fragments of wood,—and renders it inconspicuous. Much the same variety of coloring is presented by a Locust of widely different structure but often inhabiting the same situations—*Melanoplus fasciatus*.

Black, yellow, and reddish phases are noticeable in the Carolina Locust and in lesser degree in the Two-striped Locust. These occur apparently irrespective of environmental color and are due to varying proportions of pigment of these colors. The body of the Rusty or Leather-colored Locust varies widely in the same locality from a yellowish or olive green to the normal rusty red of the tegmina. The dorsal region of the head and pronotum of

Melanoplus m. atlanis and *M. femur-rubrum* is occasionally rose red. Scarcely a species can be named that does not present notable color variations, sufficient to make color in itself often of but inconsequential value in characterizing species, yet in other cases it may be extremely useful. The pattern of coloration due to markings, however, is often of great service; but structure is the only safe guide in discriminating species.

Color Determination in the Green-striped Locust, *Chortophaga viridifasciata*.

By Dr. Phineas W. Whiting.

Two color phases of *Chortophaga viridifasciata* are generally recognized,—a green and a brown. The greens are called variety *virginiana* and the browns, *infuscata*. Intermediates occur but are relatively scarce. The greens grade into purple and rarely purple marks occur on brown individuals. The browns vary from very dark brown to buff. Males are usually brown but occasionally a green male may be taken. Among the females browns and greens occur in variable percentages.

It was at first thought that these color differences might be due to mendelizing factors correlated in some way with sex. Accordingly matings were made at the Bussey Institution during the summer of 1913. Green was mated to green, brown to brown, brown male to green female, and green male to brown female. Without exception the nymphs produced were brown and remained brown throughout life. Green nymphs were taken in the field and reared in the insectary. They became brown after ecdysis. Conditions were hot and dry. Other nymphs were taken and kept in cooler, damper places. The greens under these conditions usually remained green, only occasionally turning brown. The brown, with the exception of two doubtful cases, remained brown.

At the Zoölogical Laboratory of the University of Pennsylvania experiments were performed during the spring of 1915 under more carefully controlled conditions. At a constant temperature of 100° Fahrenheit it was found that both nymphs and adults of *Chortophaga* bleached out to a light buff color. Dark

browns or greens changed to this color apparently regardless of humidity or light. Total darkness gave results in no way different from constant exposure to the light of a 100-watt Mazda lamp. Saturated humidity gave results similar to very high aridity. Considerable variation obtained among the individuals as to time of change to buff, but this was not correlated with light or moisture. Some changed very soon after exposure to high temperature while others passed through either one or two ecdyses. The change usually took place shortly after ecdysis, but occasionally occurred in the midst of an instar. A few green female nymphs retained their color through two molts, emerging as green adults. These turned buff several days after the last molt.

Purple nymphs changed to buff after one or two molts at a constant temperature of 100° Fahrenheit.

Dark brown nymphs kept at a constant temperature of 55° Fahrenheit retained their dark color.

Further experiments are necessary before conclusions are certain, but it would seem that temperature rather than light or humidity is the important factor in color determination. The fact that different individuals respond to the same conditions in different ways is evidence of genetic differences in color determination. These differences are not, however, sufficiently great to hold an individual constantly in the same color phase.

It is clear then that the so-called color varieties *infuscata* and *virginiana* are but color phases dependent to a large extent at least upon environmental conditions. These different color phases frequently are assumed by the same individual at different periods of its life.

Geographical Distribution of New England Orthoptera.

"Probably no state in the Union presents so striking a variety in its animal life as New Hampshire. Its northern and southern portions belong to distinct continental faunas; above the forest growth of its colder region rise some of the highest elevations east of the Rocky Mountains, and these bleak altitudes support a vegetation and an assemblage of animals intimately resembling those of Labrador and Greenland, while sixty miles to the south flourish animals characteristic of sub-tropical climes."

This opening paragraph of Scudder's essay on "The Distribution of Insects in New Hampshire," written in 1874, and based especially on the records known at that time of the butterflies and Orthoptera of that State, applies almost equally well to New England in its entirety as we know it today.

The Orthoptera are a heat-loving group of insects and diminish rapidly in number of species and individuals in cold climates as compared with warm. There is much difference even in the extremes of so small a district as New England, there being relatively few in northern and eastern Maine as compared with southern Connecticut. Certain species are as distinctively northern in distribution as others are characteristically southern, while others still are spread over the entire country. In these particulars the Orthoptera agree with other animals and plants and it is easily recognized that New England, small as it is, is crossed by three belts or zones of life: a northern, represented by boreal species of animals and plants; a narrow southern, containing austral species; and a broad transition belt where species of both boreal and austral derivation overlap in distribution.

The delimitation of these zones is based on data of distribution secured from studies of various groups of animals,—especially mammals, birds, and butterflies,—and on the results of botanical research also. Their boundaries are characterized by great irregularity and follow in a general way the course of the mean annual isotherms, being strongly influenced by elevation and topography. A glance at the accompanying map, Fig. 22, will render the matter clearer than pages of description. This map is derived from that prepared by S. H. Scudder to illustrate the faunal areas of New England in his monograph of the butterflies of the eastern United States and Canada (1889–1890), the isotherms contributed by Professor W. M. Davis.

The three zones or belts appear clearly, and the Transition is further subdivided into northern and southern portions according with the restricted distribution of certain species. It will be noticed at once that there is a marked interdigitation of faunal areas corresponding with the north and south extension of mountain-chains and river-valleys; the influence of the sea-coast also is noticeable. These various physical features markedly affect the climate and consequently the distribution of many

plants and animals able to withstand heat and cold to only a limited degree or amount.

The exact limits of the various zones differ somewhat among

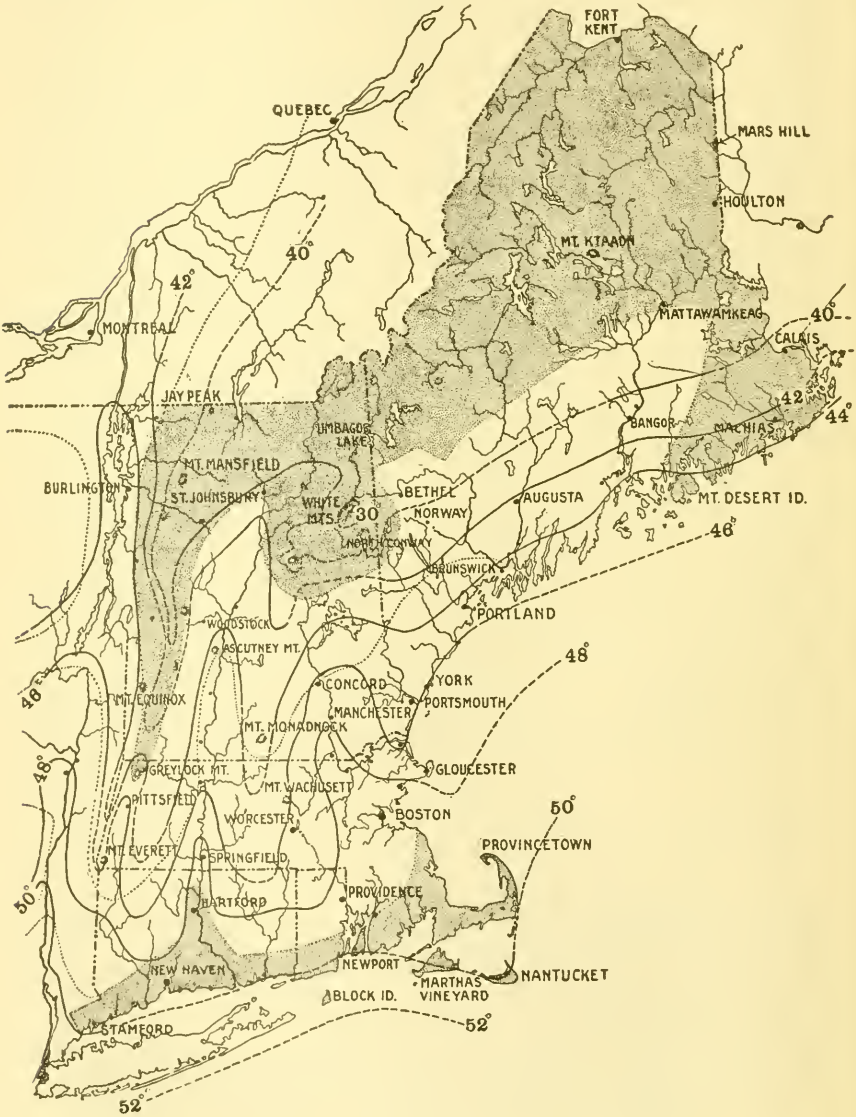

FIG. 22.—Map of New England showing life zones. (After Scudder.)

the various groups of animals and plants according to their respective needs, but the general extent and features are the same. The Boreal zone is characterized by a low temperature and great humidity. These conditions are found in New England on high mountains and in damp forests, swamps and bogs of lower elevation in the cooler parts of the district. Beginning on the coast of Maine a few miles east of Portland this zone includes the immediate shore and low-lying bogs in the adjoining country, the seaboard eastern townships, and much of the country along the eastern border of the State to the latitude of Mattawamkeag; thence its southern boundary runs southwestward to the New Hampshire line a few miles north of the Androscoggin River, encircles the White Mountain group by a southward detour, returning in the Connecticut Valley to nearly the same latitude, thence swings westward to the Green Mountains, including all the higher mountain tops of Vermont and much of their slopes, as far south as Greylock in Massachusetts, whence its western boundary runs nearly north and south, leaving the Champlain Valley in the Transition zone.

The Boreal zone is subdivided into a lower or southern Canadian belt, an intermediate Hudsonian or Subalpine belt, and a higher Arctic-alpine or barren-ground area comparable in conditions and in plant and animal life with the far North. The last-named area is restricted to the summits of Mt. Katahdin and the higher members of the Presidential Range of the White Mountains above timber-line. The Hudsonian includes the narrow belt of dwarfed trees immediately below timber-line on the higher mountains; and the Canadian zone the remainder of the boreal. Dr. Allen, in writing of the distribution of New Hampshire birds, divides the Canadian zone into upper and lower parts, characterized by different species and conditions.

But few Orthoptera are found in the Boreal zone. The most characteristic species living there in New England is the White Mountain Wingless Locust, *Podisma glacialis*. This inhabits the Hudsonian and Canadian portions of the zone from the summits of the White Mountain group to the sea-level swamps at Roque Bluff, Maine, and occurs, stranded as it were in mid-air, on the extreme tops of Mt. Ascutney in Vermont and Mt. Greylock in Massachusetts. The Northern Curve-tailed Bush-katydid, *Scud-*

deria curvicauda septentrionalis, is also apparently restricted to this zone, and the Northern Sedge Locust, *Mecostethus gracilis,* is rarely found outside of it. Three other boreal species: *Camnula pellucida, Circotettix verruculatus,* and *Melanoplus borealis,* accompany them and extend farther south in limited numbers, the first two reaching northern Connecticut, and the third northern Massachusetts on both the western and the central highlands.

The Austral zone is characterized by a much higher mean temperature and milder winters, and covers only the lowlands of Connecticut and southern Massachusetts. Typical Orthoptera inhabiting it are: *Orphulella olivacea, Amblycorypha floridana carinata, Neoconocephalus exiliscanorus, N. retusus, Conocephalus saltans, Ceuthophilus gracilipes, Eritettix simplex, Oecanthus exclamationis,* and *Anaxipha exigua.* Additional species of Austral derivation which extend farther north, reaching southwestern Maine, southern New Hampshire, or at least eastern Massachusetts are: *Paratettix cucullatus, Dichromorpha viridis, Spharagemon saxatile, Schistocerca alutacea rubiginosa, Pterophylla camellifolia,* and, near the coast: *Orphulella pelidna, Paroxya clavuliger, Neoconocephalus robustus, Conocephalus spartinae,* and *Trimerotropis maritima.* The two last and *Orphulella olivacea* are confined to the immediate sea-coast.

Another element in our fauna is represented by *Melanoplus viridipes,* which occurs along our western border from southwestern Massachusetts to northern Vermont. This species connects us with the Mississippi Valley fauna. It is probable that additional species from this direction will yet be found to inhabit New England.

The majority of our remaining species are distributed widely in the Transition belt of the country east of the Great Plains, some in the Transition and Boreal, more in the Transition and Austral; a few species extend even to the Pacific Ocean.

While many more data must be secured before it will be possible to map accurately and completely the distribution of all of our species, the following lists may be helpful and suggestive. Some shifting will probably be necessary in case of the less known species.

1.—Probably found in the entire district.

Labia minor

Ceuthophilus brevipes
maculatus
neglectus
Conocephalus brevipennis
fasciatus
Neoconocephalus ensiger
Orchelimum gladiator
vulgare
Scudderia curvicauda
furcata
pistillata
septentrionalis

Gryllotalpa hexadactyla
Gryllus assimilis
Nemobius carolinus
fasciatus
palustris

Acrydium granulatum granulatum
ornatum
Arphia sulphurea
Chloealtis conspersa
Chorthippus curtipennis
Chortophaga viridifasciata
Mecostethus lineatus
Melanoplus mexicanus atlanis
bivittatus
fasciatus
femur-rubrum
luridus
mancus
Nomotettix cristatus
Pardalophora apiculata
Tettigidea lateralis parvipennis

2.—Austral (+ = extended limits).

Manomera blatchleyi

Parcoblatta uhleriana

Amblycorypha floridana carinata
Ceuthophilus gracilipes
latens
Conocephalus saltans
Neoconocephalus exiliscanorus
retusus
Pterophylla camellifolia +

Anaxipha exigua
Nemobius cubensis
griseus +
maculatus

Neoxabea bipunctata
Oecanthus exclamationis
Tridactylus apicialis +
Dichromorpha viridis +
Eritettix simplex
Hesperotettix brevipennis +
Orphulella olivacea
pelidna +
Paratettix cucullatus +
Paroxya clavuliger +

3.—Austral and Transition.

Parcoblatta pensylvanica
virginica

Diapheromera femorata

Amblycorypha oblongifolia
rotundifolia
Atlanticus americanus
testaceus

Ceuthophilus lapidicola
Scudderia texensis

Oecanthus angustipennis
nigricornis
niveus
pini
quadripunctatus

Acrydium arenosum angustum
Arphia xanthoptera
Dissosteira carolina
Hippiscus rugosus
Melanoplus confusus
punctulatus
Orphulella speciosa
Pseudopomala brachyptera
Psinidia fenestralis
Schistocerca alutacea
Scirtetica marmorata marmorata
Spharagemon bolli
collare scudderi
saxatile

4.—Boreal.

Ceuthophilus terrestris
Scudderia curvicauda borealis
Acrydium granulatum incurvatum
hancocki
Camnula pellucida
Circotettix verruculatus
Mecostethus gracilis
Podisma glacialis

5.—Coastwise.

Anisolabis maritima
Conocephalus spartinae
Neoconocephalus robustus
Orchelimum concinnum
Orphulella olivacea
Trimerotropis maritima

6.—Appalachian.

Melanoplus viridipes

7.—Insufficiently known.

Mecostethus platypterus
Melanoplus dawsoni

8.—Domiciliary,—all introduced.

Euborellia annulipes
Prolabia arachidis
Blatta orientalis
Blattella germanica
Periplaneta americana
australasiae
Pycnoscelus surinamensis
Diestrammena marmorata
Hapithus vagus

9.—Adventive or introduced.

Anisolabis maritima
Forficula auricularia
Epilampra maya
Eurycotis opaca
tibialis
Hormetica advena
Nyctibora laevigata
noctivaga
Panchlora cubensis
exoleta
Mantis religiosa
Paratenodera sinensis
Stagmomantis carolina
Leptophyes punctatissima
Neoconocephalus triops
Gryllotalpa gryllotalpa
Phoetaliotes nebrascensis
Schistocerca serialis

Scudder, S. H. "The Distribution of Insects in New Hampshire," in Hitchcock, Final Rept. Geol. N. H., vol. 1, chap. 12, p. 331–384, 2 maps, 1874.
Hoffman, Ralph. Guide to the Birds of New England and Eastern New York, p. 13–17, map, 1904.
Allen, G. M. "The Faunal Areas of New Hampshire," in the "Birds of New Hampshire," Proc. Manchester Inst. Arts and Sciences, vol. 4, pt. 1, p. 36–53, 1902.
Morse, A. P. "The Distribution of the New England Locusts." Psyche, vol. 8, p. 315–323, map, 1899.

Colonization of New England; Dispersal Routes.

It is believed that the present land surface of New England underwent complete glaciation. In that case the existing distribution of its Orthoptera was brought about by dispersal from beyond its limits. The boreal and transition species, pushed southward by the advancing cold of the Glacial Period, probably found no great difficulty in immediately following at close quarters the diminishing ice-sheet in its retreat northward, and spread over the land surface as fast as it became clothed with vegetation and the physical conditions permitted. The later advent of the austral species, however, was probably along more definite routes.

Whether the ice-sheet at its farthest extent reached the sea, or whether it was bordered by a broad land surface extending to the edge of the continental shelf, may never be positively known; but there can be no doubt that at some time in the past geological history of the continent, and in a comparatively late time, a wide sandy plain extended northeast from New Jersey to the Grand Banks of Newfoundland.

Such a condition is indicated by the discontinuous distribution of many plants and animals peculiar to sandy districts, some of which are known today only from the extremes of this territory —New Jersey and Newfoundland—others from various intermediate but still widely separated points. With the wearing down and subsidence of this part of the continent, the distribution of these species, at one time continuous, was broken up, until they now remain in scattered local colonies maintaining an existence only in especially favorable spots (*e.g.*, among Orthoptera, *Conocephalus saltans, Hesperotettix brevipennis, Hippiscus rugo-*

sus), thus paralleling in an interesting way the island-like distribution of certain boreal species on the cool mountain-tops of the Transition belt (*e.g.*, among Orthoptera, *Podisma glacialis*).

Entering this broad area of sandy land from the southwest, these campestrian sand-loving species of austral descent overspread it far to the northeast; and following up the course of the north- and south-running river valleys, with their exposed bars and shores and the scantily clad plains between, they spread far inland, in some cases even to the bases of the high mountains.

Later, when the general spread of plant life had clothed the land surface with vegetation, and the accumulation of vegetal débris and formation of humus had improved the soil and developed its moisture-retaining properties, the phytophilous and humicolous species came.

In a similar manner the halophile species of the tidal marshes and immediate seashore became dispersed (*e.g.*, among Orthoptera, *Conocephalus spartinae, Orchelimum concinnum, Trimerotropis maritima*, and perhaps *Paroxya clavuliger*.

Local Distribution.—Whatever their geographic or zonal distribution may be, whether eastern or western, boreal, austral, or transition, Orthoptera differ much specifically in the character of the haunts which they frequent, and consequently may be arranged in groups of species associated through a common fondness for surroundings of a particular type.

It is a stimulating test of one's knowledge of their habits, ability to discriminate environmental conditions, and judgment of probabilities, to make a list of the species likely to be found in a given spot, and by collecting strive to verify it. "Can I expect to find such and such a species here? If not, why not?" When sufficiently experienced, a high degree of accuracy is possible.

It scarcely need be said that any classification of habitats will vary much in details according to the habits of the group chosen. Compare for instance, the Locusts and the Crickets in reference to the time of day when active and the proportionate number living in the ground, on the ground, and above the ground.

After a wide experience in New England, the southeastern States, and on the Pacific coast, the author proposed a classification of Locust habitats and societies only (Publ. 18, Carnegie Inst. Wash., 1903). This was based on the physical character of

the environment in which the species was most abundant or most certain to be found, *i.e.*, in which most of its activities were carried on. It is as follows:

Geophilous (soil-loving) divison.
  Campestrian (open field) group.
    Xerophile (drought-loving) societies.
      Saxicolous (rock-inhabiting) species.
      Arenicolous (sand-inhabiting) species.
      Humicolous (loam-inhabiting) species.
    Hygrophile (moisture-loving) societies.
      Humicolous species.
      Paludicolous (marsh-inhabiting) species.
      Limicolous (shore-inhabiting) species.
  Sylvan (forest) group.
Phytophilous (plant-loving) division.
  Campestrian group.
    Xerophile societies.
    Hygrophile societies.
  Sylvan group.
    Thamnophile (thicket-loving) societies.
    Dendrophile (tree-loving) societies.

"Geophilous locusts are those which freely come into direct contact with the soil and whose local distribution is largely controlled by its character. Phytophilous locusts, on the other hand, have much closer relations with the vegetal covering of the soil, be it grass or tree. This primary difference in habits is accompanied by a structural difference in the relative development of the tarsal pulvilli—large in the plant-perching species, diminutive, obsolescent, or aborted in the soil-inhabiting species. In eastern North America, with few exceptions, the Tettiginae[1] and Oedipodinae[2] are geophilous; the Tryxalinae[3] and Acridiinae[4] are phytophilous" (Morse).

As applied to the New England species, this arrangement works out thus:

[1] Pygmy Locusts, Acrydiinae of this work.
[2] Band-winged Locusts, Oedipodinae of this work.
[3] Slant-faced Locusts, Acridinae of this work.
[4] Spine-throated Locusts, Locustinae of this work.

GEOPHILOUS LOCUSTS.

Xerophile Group.

Saxicolous species:	*Spharagemon saxatile, Circotettix verruculatus.*
Arenicolous "	*Scirtetica marmorata, Psinidia fenestralis, Trimerotropis maritima.*
Humicolous "	the remaining Oedipodinae.

Hygrophile Group.

Limicolous species:	*Paratettix cucullatus.*
Paludicolous "	*Tettigidea, Acrydium granulatum, A. arenosum.*
Humicolous "	*Nomotettix, Acrydium ornatum.*

PHYTOPHILOUS LOCUSTS.

Campestrian Group.

Xerophile species:	*Pseudopomala, Orphulella pelidna, O. speciosa, Melanoplus m. atlanis, Hesperotettix brevipennis.*
Hygrophile "	*Dichromorpha, Orphulella olivacea, Chorthippus, Mecostethus, Paroxya, Melanoplus bivittatus, M. extremus, M. femur-rubrum.*

Sylvan Group.

Thamnophile species:	*Podisma glacialis, Melanoplus mancus, M. fasciatus, M. viridipes, M. scudderi.*
Dendrophile "	*Melanoplus punctulatus.*

This classification was not intended for the Long-horned Grasshoppers or the Crickets, both of which need a different grouping.

Later on, Hancock (1911) brought out a somewhat similar classification arranging all the Orthoptera living in the vicinity of Chicago in fifteen groups of equal rank, the basis being the place of oviposition. Since then others have made attempts from the ecological point of view; some of them with but poor success, due largely to very limited experience and from study of an extremely small area in an unsuitable region, too far north to give good results.[1]

[1] In this connection the old adage, "One swallow does not make a summer" should be carefully heeded. Only extended experience and critical observation, or an equivalent mass of data accumulated over a long time and under equally diverse conditions will enable one to estimate correctly the ecological status of a plant or animal. The presence of a Bunch-grass Locust in a salt-marsh does not prove it to be a halophile species any more than the presence of a fish in the milk proves that milk is its natural environment. Circumstances alter cases and wise judgment waits on common-sense.

Vestal, however, in spite of the handicap of a northern field of study, has made a valuable contribution to the subject in an interesting paper on the "Local Distribution of Grasshoppers in relation to Plant Associations" (Biol. Bull., Aug. 1913, vol. 25, p. 141–180), and his illustrative diagram is especially suggestive and interesting.

Fox, in his paper on the "Orthopteran Faunistics of Eastern Pennsylvania and Southern New Jersey" has also contributed materially to the literature of local distribution (see Proc. Acad. Nat. Sci. Phila., June, 1914, p. 441–534).

Wingless and Vestigial-winged Orthoptera.

A subject of especial interest in this connection is the distribution and origin of flightless forms. Such cases are by no means restricted to the Orthoptera among insects but are especially conspicuous in this order, examples being numerous in each family.

It was once supposed that Locusts with wings greatly reduced in size or entirely lacking were especially characteristic of alpine summits because many species had been found there, and this condition was thought to be due to the influence of high winds. This myth has vanished, however, having been based on insufficient information. In my "Researches" (Publ. 18, Carnegie Inst. Wash.) I have summed up the evidence with reference to North America and pointed out that flightless species and genera of Locusts are equally as plentiful in lowland areas as on mountain tops, and that they are, as a rule, inhabitants of thickets.

"If the members of a group of locusts, be it genus or subfamily, differ widely in habits as regards the two kinds of environment—open field or thicket—we find a corresponding difference in wing-length, as witness the genus *Melanoplus*, the group Melanopli, the subfamily Locustinae. On the other hand, if uniformity of habits characterizes a group, similarity of structure accompanies it, as witness the Oedipodinae, a subfamily characteristic of open, more or less arid surroundings, inhabiting barren fields and washes, the drifting dunes of the seashore, or bare crags of mountain summits, shy and wary of approach, seeking safety in flight, and with few exceptions equipped with large and powerful wings.

"The advantages of progression by flight—dispersal widely and

easily effected, often aided by the wind, ease of escape from many enemies, etc., and the superiority of this mode in open lands—are evident to all. On the other hand, long wings and locomotion by flight are disadvantageous amid dense underbrush, where a leaping mode of progression has decided advantages. Organs unused or disadvantageous tend to dwindle and disappear; hence the loss of wings. In short, flightlessness in locusts is a more complete adaptation to a leaping mode of progression brought about by life in situations where flight is difficult or impracticable and consequently disadvantageous.

"Among other Orthoptera flightless species are numerous both in saltatorial and non-saltatorial families. On examination we find that genera and species inhabiting trees and shrubs (*Scudderia, Microcentrum, Pterophylla, Oecanthus*, etc.) and open grassy lands (*Neoconocephalus*), are prevailingly long-winged, while those inhabiting undergrowth (*Conocephalus* in part, *Odontoxiphidium*), crevices and caves (Ceuthophili, Decticinae, many Blattidae and Gryllidae), or burrows, either of other species or of their own make (*Cryptocercus, Myrmecophila, Gryllotalpa*) are very likely to be flightless, an evident adaptation in structure to habits directly parallel with that of flightless locusts (compare also with ants and termites).

"On close analysis it is found that Orthoptera frequenting habitats involving passage over open spaces of considerable extent, such as fields, between trees in forests, and bushes or thickets in deserts, are usually long-winged, flying species; and others dwelling in an environment of more or less dense, intricate, interlacing vegetal growth, be it sub-alpine or tropical, in forest or swamp—or in burrows, crevices, etc.—in short, in stations where wings are not needed or are at a disadvantage, are very generally flightless.

"The fact that the heavier-bodied female is more frequently partially or completely wingless than the male and that the tegmina in the male when used as musical instruments are retained in a less degenerate condition (even when entirely useless in flight), confirms this view."

Whatever the cause of this condition, the subject is an interesting one for experimentation. It may be that the question of nutrition is concerned; it is thought to be involved in some

other orders. Why should long-winged individuals of a species be met with in one part of the country, and only flightless examples in other parts?

TABLE OF NATIVE AND EXOTIC ORTHOPTEROIDEA RECORDED FROM NEW ENGLAND

	Total	Native	Introduced	Established	Adventive
Dermaptera	6	1 (?)	5	5	1
Blattidae	17	3	14	5	9
Mantidae	3	0	3	0	(1?)
Phasmidae	2	2	0	–	0
Tettigoniidae	33	30	3	2 (?)	2
Gryllidae	19	17	2	1 (?)	2
Acrididae					
Acridinae	11	11	0	–	–
Oedipodinae	15	15	0	–	–
Locustinae	18	17	1	–	1 ?
Acrydiinae	8	8	0	–	–
Total Acrididae	52	51	1		
Grand totals	132	104 (?)	28	13 (?)	16 (?)

From this table it is evident that of the 132 species of Orthoptera and Dermaptera recorded from New England, 104 are native species and that 28 which do not naturally occur within our limits have been introduced purposely or accidentally. Of these, 2 species of predaceous habits (or possibly 3) were intentionally brought in to prey on other insects. Of the others, 24 were presumably stowaways in merchandise. Of these again, only 10 or 12 have succeeded in maintaining themselves here for any considerable period; the others are random individuals of species for the most part living in warm climates, introduced with tropical fruits, and unlikely to survive under natural conditions. The exact status of two (the European Mole-cricket and the European Bush-katydid) whether successfully colonized or not, is at present unknown. The common European Earwig is probably firmly established (more's the pity!) but as yet, fortunately, occurs in only a limited area. Five species of exotic Roaches are of frequent occurrence, three of them being widely distributed under

artificial conditions; these must probably be reckoned as permanent additions to our insect fauna.

Considered from an economic point of view, eight introduced species are to be regarded as noxious or at least undesirable importations, *viz.*, the European Earwig, European Mole-cricket, Asiatic Cave-cricket, and five species of Cockroaches.

Injuries by Locusts and other Orthoptera in New England.

Three native species of Locusts (*Melanoplus m. atlanis, M. femur-rubrum, Camnula pellucida*) have in times past done severe damage and are always destructive; three others (*Melanoplus bivittatus,*[1] *Encoptolophus sordidus, Orphulella speciosa*) do much damage annually which is not always readily appreciable, and are potentially dangerous; two Field-crickets (*Gryllus assimilis, Nemobius fasciatus*) also belong in this last group. The injuries caused by Tree-crickets (of which three species are abundant) are perhaps offset to a considerable degree by their destruction of aphids. The Tettigoniidae (Katydids, Long-horned Grasshoppers, etc.) seem not to be noticeably injurious except possibly the three commonest species of Bush-katydids (*Scudderia*) when occurring in the vicinity of cranberry bogs. The Walking-stick, *Diapheromera femorata,* has been reported at times as severely injurious elsewhere in limited areas, but it is rarely other than a scarce insect in New England.

While much damage in the aggregate is done annually in New England by Locusts, severe outbreaks are usually local in character and of comparatively limited extent. They show a tendency to recur in the same district at irregular intervals of several years. This is doubtless due to specially favorable natural conditions of soil and climate, a well-drained sandy loam and several dry seasons generally being necessary to develop serious conditions. Southwestern Maine, southern New Hampshire, certain counties in Vermont and Massachusetts, but especially the sandy intervales of the Merrimack valley in central New Hampshire,

[1] An outbreak of this species at Dummerston, Vt., in 1915, 1916, and 1917, was checked in the last year to a large degree by a parasitic thread-worm, as many as 40 worms sometimes infesting a single Locust.

have suffered repeated visitations. Scudder (Distribution of Insects in New Hampshire) quotes an interesting account of their ravages in Pownal, Cumberland Co., Maine, in the early part of the last century. This presents such a graphic picture of the destructive ability of certain of our native species that I give it here in full.

"During the haying season the weather was dry and hot, and these hungry locusts stripped the leaves from the clover and herds-grass, leaving nothing but the naked stems. In consequence, the hay-crop was seriously diminished in value. So ravenous had they become that they would attack clover, eating it into shreds. Rake and pitchfork handles, made of white ash, and worn to a glossy smoothness by use, would be found nibbled over by them if left within their reach.

"As soon as the hay was cut, and they had eaten every living thing from the ground, they removed to the adjacent crops of grain, completely stripping the leaves; climbing the naked stalks, they would eat off the stems of wheat and rye just below the head, and leave them to drop to the ground. I well remember assisting in sweeping a large cord over the heads of wheat after dark, causing the insects to drop to the ground, where most of them would remain during the night. During harvest time it was my painful duty, with a younger brother, to pick up the fallen wheat heads for threshing; they amounted to several bushels.

"Their next attack was upon the Indian corn and potatoes. They stripped the leaves and ate out the silk from the corn, so that it was rare to harvest a full ear. Among forty or fifty bushels of corn spread out in the corn-room, not an ear could be found not mottled with detached kernels.

"While these insects were more than usually abundant in the town generally, it was in the field I have described that they appeared in the greatest intensity. After they had stripped everything from the field, they began to emigrate in countless numbers. They crossed the highway and attacked the vegetable garden. I remember the curious appearance of a large, flourishing bed of red onions, whose tops they first literally ate up, and, not content with that, devoured the interior of the bulbs, leaving the dry external covering in place. The provident care of my mother, who covered the bed with chaff from the stable floor, did

not save them, while she was complimented the next year for so successfully sowing the garden down to grass. The leaves were stripped from the apple-trees. They entered the house in swarms, reminding one of the locusts of Egypt, and, as we walked, they would rise in countless numbers and fly away in clouds.

"As the nights grew cooler they collected on the spruce and hemlock stumps and log fences, completely covering them, eating the moss and decomposed surface of the wood, and leaving the surface clean and new. They would perch on the west side of a stump, where they could feel the warmth of the sun, and work around to the east side in the morning as the sun reappeared. The foot-paths in the fields were literally covered with their excrements.

"During the latter part of August and the first of September, when the air was still dry, and for several days in succession a high wind prevailed from the northwest, the locusts frequently rose in the air to an immense height. By looking up at the sky in the middle of a clear day, as nearly as possible in the direction of the sun, one may descry a locust at a great height. These insects could thus be seen in swarms, appearing like so many thistle-blows, as they expanded their wings and were borne along toward the sea before the wind; myriads of them were drowned in Casco Bay, and I remember hearing that they frequently dropped on the decks of coasting vessels. Cart-loads of dead bodies remained in the fields, forming in spots a tolerable coating of manure."

While Scudder attributes this outbreak to the Red-legged Locust (*Melanoplus femur-rubrum*), it is highly probable that it was caused primarily by the Lesser Locust (*M. m. atlanis*), which had not been recognized at that time as a distinct species inhabiting New England. This is indicated particularly by their tendency to migrate.

Remedies.

Since the introduction of arsenical poisons and their use combined with attractive baits, and of mechanical means such as hopper-dozers to capture the young in large quantities, the outlook for the agriculturist to combat the pests successfully is much

brighter, provided repressive measures are undertaken early in the active life of the insect.

When the topography permits, *i.e.*, in level fields free from stumps and stones, the use of hopper-dozers and hopper-catching machines is helpful, fairly effective, and on a large scale more economical. The cost of poisoned baits and their application in quantity ranges from 25 to 40 cents per acre; the expense of a hopper-catching machine in Utah has been stated at 20 to 30 cents per acre the first year (including the construction of the machine) and 9 to 12 cents thereafter, on a hundred-acre basis, with a large amount of useful by-product in the shape of dried hoppers valuable for winter poultry-feed, as many as 40 bushels having been captured and sacked up in a few hours (Ball, Journ. Econ. Ent., vol. 10, p. 135, 1917).

The hopper-dozer is a similar machine using kerosene or tanglefoot as a killing agent; of course the catch is useless as a poultry feed. As many as 300 bushels of Grasshoppers have been collected on 100 acres of alfalfa in the West (U. S. Dept. Agric., Farmers' Bull. 747).

When circumstances permit, areas that contain many Locust eggs should be plowed in the fall, the exposure of the eggs to winter weather resulting in their destruction. In all cases, the coöperation of communities is essential for the best results.

Wherever practicable, hogs and poultry may be utilized with good effect as checks upon undue Locust multiplication, turkeys being especially valuable; the only drawback about this preventive measure is that overeating of Grasshoppers by young chickens or turkeys sometimes results in death from the accumulation in their crops of large numbers of the spiny hind legs of the insects. Blatchley has stated the case admirably as follows: "About the best remedy for Orthoptera on a farm is a large flock of turkeys. Under the leadership of an experienced gobbler, almost their entire time during the summer and fall months is spent in wandering over the fields and pastures in search of the fat and juicy nymphs of locusts, grasshoppers and crickets. Indeed, most of the luscious white and brown meat of our Thanksgiving and Christmas dinners was once grass, then grasshopper, and finally turkey. No better and more practical remedy can be devised, for the damage which the insects do, is, especially in these days

of 'turkey trusts,' often more than compensated by the value of the pounds of flesh which this domesticated fowl stores up from its favorite food of locusts."

The most practical remedy for outbreaks of Orthoptera under the usual New England conditions is doubtless the use of a poisoned bait, such as poisoned bran or the Criddle mixture. These are about equally effective. They are prepared as follows:

Poisoned bran bait[1]

Coarse bran or "shorts"	25 pounds
Paris green or white arsenic	1 pound
Lemons or oranges	6 fruits
Cheap molasses, "black-strap" or cattle molasses (a strong-smelling article is necessary)	2 quarts

Mix the bran and poison thoroughly together while dry. Chop the fruit fine (watermelons, tomatoes, etc., may be substituted if desired) and add to the bran. Add water as necessary. Pour on the molasses or syrup and knead thoroughly. This quantity is sufficient for five acres.

The modified Criddle mixture is made as follows:

Fresh horse droppings	½ barrel
Paris green or arsenic	1 pound
Lemons or oranges, finely chopped	6 or 8 fruits

Mix thoroughly.

Apply by sowing broadcast over the infested fields, either by hand or grain-seeder, in late afternoon or early morning, making sure that it is broken up into flakes, not left in lumps. The bait will not show its full effect until from one to five days have elapsed. To be most effective and to save material, crops, and money, it should be applied while the insects are young.

In combating the European Earwig, poisoned bread bait made as follows is especially recommended:

Stale white bread	16 pounds
Paris green	1 pound

Grind the bread fine in a meat-chopper and thoroughly mix the Paris green with it while dry. Stir and slowly add water enough to make a mixture which will run through the fingers and which,

[1] Sawdust has also been used successfully to replace a part or all of the bran.

when thrown broadcast with some force, will break into small particles. The addition of cheap honey makes the bait more effective but is not essential.

This bait should be spread broadcast between the hours of dusk and 9 P.M. in gardens and infested lawns, throwing it with sufficient force to scatter it in fine particles, preferably on warm evenings, from May 15 to June 15. Three applications are recommended.

Additional measures of control are traps made of 3-inch flowerpots with excelsior stuffed into the bottoms, inverted on 9-inch sticks set in the ground near plants where Earwigs are numerous. These are to be emptied each morning into a pail of water with a film of kerosene on the top. Still other measures recommended involve the use of arsenical sprays on foliage and flowers attacked by the insects, or contact sprays applied while they are active at night and in their shelters by day, and the use of bands of sticky material to bar them from crawling into porches and houses (Bull. 566, U. S. Dept. Agric.).

Enemies.

The Orthoptera as a whole are classed as injurious because of their herbivorous habits, the Mantidae alone being regarded as beneficial, since they prey upon insects, though doubtless destroying useful as well as noxious species. Since the order is so largely injurious as regards man's interests, it is well to point out that there are many natural enemies which serve to hold it in check. But for these it would be an even greater scourge.

Among the agents which serve to reduce its harmfulness may be ranked certain bacterial and fungous diseases. These are usually more effective in moist seasons. In late summer it is not uncommon to find examples of the Carolina and Two-striped Locusts clinging fast to the tops of tall weeds and grasses. A close examination reveals that they are dead, discolored, and perhaps reduced to empty shells by a fungus (*Empusa grylli*), attack by which impels them thus to climb and cling till grim death overtakes them high above the ground. This effect of the disease is of benefit to the fungus since the elevation insures a wider dispersal of its spores.

Important internal parasites are species of *Gordius* or *Mermis*, hair-worms or 'hair-snakes,' thread-like creatures from several inches to a foot or two in length which develop in the body, prevent the normal growth of the organs, and finally weaken and kill their hosts.

In early spring one often sees crawling over the ground or hiding under stones in fields where Locusts were numerous the previous autumn, numbers of small scarlet mites, with eight legs and a plump, velvety body. These are adults of the locust-mite, *Trombidium locustarum*. The females soon lay 300 to 400 eggs in a chamber in the soil, from which in due season hatch tiny, six-legged, very active young. These attach themselves at the first opportunity to young Locusts by means of their sucking mouth-parts, usually in some protected situation where the body-wall is thin, such as under the free edge of the pronotum or between the wing-pads, where they remain, even after the Locust becomes mature, sucking out its life fluids, growing corpulent at the expense of their host, which is usually much weakened by their presence and hops and flies clumsily. When full-grown, the larval mites drop to the ground, enter the pupal state, and later on, sometimes in autumn, sometimes not until spring, become adults. Locusts bearing numbers of these mites upon their wings are common objects in the fall, and I have seen them so heavily infested as to appear red-winged at a little distance, from this cause. Even the locust eggs are attacked by these mites while burrowing in the soil, and many are destroyed at that time. The eggs are also devoured by the larvae of bee-flies and blister-beetles with curiously adapted and specialized life history and transformations.

Again, one may frequently see in midsummer, flying about Locusts or perched nearby and sharply watching them, short, thickset, grayish flies, somewhat resembling large house-flies. These are parasitic Tachina flies. When the Locust essays flight, its enemy, the fly, darts after it and strives to fasten an egg on its neck or at the base of the wing. If successful, a maggot shortly hatches therefrom, penetrates the body of the Locust, and there feeds upon and destroys it.

Young Locusts are the prey of many carnivorous insects, notably the swift-running ground- and tiger-beetles in both larval

and adult stages. Some digger-wasps too, hunt for, paralyze by stinging, and store them away as food for their young.

Among the higher animals they have many enemies. Frogs, toads, salamanders, snakes, and lizards (rare in New England) feed largely on Orthoptera. Birds eat an enormous number; Blatchley lists nearly fifty birds known to feed upon them in Indiana, nearly all of which inhabit New England. Field-mice, moles, and shrews give them a place in their diet. Skunks fatten upon them. The farmyard cat awaits eagerly the feast that arrives when the loaded hay-wagons draw in from the fields and captures many as they fall from the fragrant hay. Even the aristocratic fox does not scorn them for breakfast when larger game is not forthcoming, striking them down with blows of his fore-paws and crunching them with satisfaction.

Methods of Collecting and Preservation.

Collecting.—Probably no group of insects, with the single exception of the day-flying butterflies and moths, may be so readily and satisfactorily observed and studied in the field as the members of this order, especially the "Grasshoppers" or true Locusts. This is due to their size, which is above the average; their haunts, in fields, pastures, and waste places frequented by man; their coloration, which is often conspicuous and frequently attractive; and to the sound-producing habits of many species, which call attention to their presence when it might otherwise be overlooked.

It is an easy task to go into the fields and secure several hundreds or thousands of Orthoptera, but an entirely different undertaking to secure a score of specimens of each species inhabiting an area even half the size of New England, if its surface is well diversified. Success in such an undertaking depends primarily on a close study of the particular habits of each species, a careful discrimination of their various habitats, thoroughness, and perhaps above all, persistence.

It is true of Orthoptera as of other creatures, that in order to study and secure them it is necessary to go where they live, and at the proper time: in other words, the season of the year when collecting is done has much to do with success. Who carefully

plans a hunting-trip before going into the field has the game half-way into his bag.

When to collect.—A few species of Orthoptera (Acrydiinae—Pygmy Locusts) pass the winter as adults, are common in spring and fall, and scarce in midsummer, being then chiefly in the egg stage. Several others (Coral-winged, Green-striped, and Spring Yellow-winged Locusts) hibernate as nymphs and mature in early spring; the adults become scarce in midsummer and die off before autumn. The majority of species spend the winter in the egg stage, hatch in the spring, grow rapidly, become mature in midsummer, and are to be found as adults during the remainder of the season. Consequently from mid-July to October is the most favorable time as a whole for securing specimens.

Where to collect.—Speaking generally, the greatest number of species will be secured where the greatest variety of habitats occurs within a relatively small area. Such conditions are offered by the borders of fields and woodlands in diversified unimproved surroundings. One must, however, explore seashore and mountain top, salt-marsh and dune, sand-bank and swale, cave and crag, before he can claim to know the orthopteran fauna of a district. He must wander by day and night with ears and eyes, mind and muscles alert to seize the opportunity that may not come again. He must stand ready to learn all that is possible from books, from the observations of experienced collectors in the same and other areas, to adapt these data to his needs, and to correlate his observations with theirs.

Collecting apparatus.—For collecting specimens a net is indispensable and the first important piece of apparatus to be secured. There are many patterns on the market and the collector should take into consideration the exact character of the work involved before purchasing; beyond that, it is a matter largely of individual preference, aside from certain necessary details. For personal use I have found some of the various landing-net frames made for anglers and sold at sporting-goods stores very satisfactory. The net of the orthopterist receives much harder use than that of most other collectors of insects and needs to be able to stand rough work. In the West, for capturing the large, alert, rapidly flying Oedipodinae, etc., I used to advantage a cane ('bamboo') handle fully six feet long with a fifteen-inch ring at

the end made of a piece of springy brass or steel which was slipped inside the handle when not in use. A handle of this length is cumbersome in traveling and is longer than necessary for most work in the East, where one of five feet is preferable. With a rubber tip on the end such a handle forms a useful staff of much assistance in walking and mountain climbing, is not too long for convenience, and is rigid enough to stand hard use. For traveling, a jointed rod and folding ring which allow the whole to be placed in a suit-case are to be preferred, and though the joints soon wear loose and long service cannot be expected of it, this is the form which is most satisfactory for any but the most strenuous work. The net-ring should be so constructed (some are not!) as to allow the net to be slipped off and replaced by another with a minimum of time and effort.

A convenient though not very stiff net-ring may be made from a piece of band-saw steel of any length to suit, which may be coiled up and carried in the pocket till needed. This is held by a brass mounting with a coarse screw thread in the base enabling it to be attached to a stick of suitable size which may usually be secured without difficulty. A desirable additional detail consists in dividing the net-ring into four pieces, twisting their ends into the plane of the ring (to prevent lateral movement when in use), and riveting them together. This allows the ring to be folded up with the net upon it and placed in the pocket, or whipped out and put into action with little delay.

Nets should be made of close-meshed canopy-lace or bobbinet if it is desired to be able to strike with great speed at rapidly flying insects. If wide-meshed, the doubled hind legs of the insects slip through the meshes and their owners are likely to be damaged. For sweeping, a net of heavy sheeting will wear much longer and capture even the smallest specimens uninjured. A combination net for general collecting may be made of open-meshed cheese-cloth with a facing around the opening of doubled heavy sheeting through which the net-ring can be quickly thrust and it is perhaps the most satisfactory material as a whole. The net must hang loosely at the ring, not drawn in, for if so, many specimens will be knocked out of it instead of scooped in. It should be rounded at the bottom, with somewhat tapering sides, and less than an arm's length in depth for convenience, though

always with an end long enough to be whipped over the ring to prevent escape of the captured insects.

Most Orthoptera are caught by 'sweeping'—this consists in swinging the net rapidly from side to side through the grass and herbage in such a way as to capture the insects as they fall or leap. If they are active, upward-leaping or flying species the upper edge of the ring should precede; if likely to drop to the ground, the lower edge. The long-handled, two-handed net may be conveniently used in one hand by carrying the end of the handle in the arm-pit. The more alert species can often be captured only by 'marking down'—that is, noting the exact spot where they alight after flight, approaching carefully, and sweeping them in by a sudden swing of the net while at rest or when they start to fly.

For killing specimens nothing is so convenient and generally satisfactory as a cyanide bottle of six or eight ounces' capacity with wide mouth ('horse-radish' pattern). It is well to have three or four available, one for Acridians, one for the more delicate Crickets and Locustarians whose antennae are subject to injury, and the others to use as duplicates while specimens in the first are dying. When specimens are large and very numerous larger bottles or jars are desirable, and for tiny Crickets and Pygmy-locusts long vials are convenient and large enough. It is well in all cases to jam a disk of blotting-paper down upon the bottom and to place fragments of the same in the bottle for the insects to kick against; the paper absorbs moisture and saliva, which Orthoptera often give off in quantity, and thereby lessens injury. In the very high temperatures of Arizona and southern California, specimens must not remain long exposed to the fumes of cyanide, which act upon the colors, reddening the yellow tints. Exposure to chloroform sometimes has the same effect on some Melanopli and Schistocerca species.

While the net and the killing-bottle are the indispensable tools with which nearly all of the specimens will be secured, traps are an important aid in capturing Roaches, Stone-crickets, and Earwigs. A very effective roach trap, designed by Professor F. L. Washburn (Journ. Econ. Ent., vol. 6, p. 327–329, 1913), consists of a wide-mouthed bottle laid on its side, into the mouth of which is stuck a paper cone or funnel with an opening large

enough to admit the insects. This is baited with banana peel or other fruit parings and placed in a suitable situation, preferably in the dark, and captures them in numbers. Mr. Morgan Hebard of the Academy of Natural Sciences of Philadelphia, a special student of the Orthoptera, has used with marked success a glass fruit jar or tin containing an inch or two of molasses. This is sunk in the ground to its top, and proves a killing bait for Roaches, both winged and wingless, and for Stone-crickets. Such a trap should be visited every day or two, the catch should be removed, washed in clean water, and pinned or pickled. Almost any receptacle providing darkness and shelter is effective in trapping the European Earwig,—inverted flower-pots with the hole stopped with a cork, and pieces of the hollow stem of sunflowers in which bits of the sweet pith remain, are used abroad where the insects are abundant.

Representatives of every family have been recorded as attracted to lights, sometimes in large numbers. Powerful electric arc lights, kerosene trap-lanterns, and even lighted windows frequently draw their victims and should not be forgotten by the collector.

Besides seeking them in their natural haunts one should always be alert to detect the various sounds which they produce; by following these up much may be learned regarding habits and habitats, and captures often effected.

Preservation of Specimens.

In the field, specimens on removal from the killing-bottle may be conveniently carried home in tin or pasteboard boxes without pinning or packing. They must not be allowed to become dry and brittle, or to get besmirched unduly with the 'molasses' of their fellows (here again scraps of paper are indicated). Shortly after death a stiffening of the muscles—*rigor mortis*—sets in and lasts for several hours. During this stage, handling of the specimens is very likely to result in breaking off the hind legs of the saltatorial forms, which are very easily detached at this time. With due precaution, however, they may usually be packed for shipment without much injury.

Immature specimens, especially of the softer-bodied families, and the earlier stages, are best preserved in liquid,—alcohol or

formaldehyde. This should be done also with at least some of each sex of adult Ceuthophilus, whose abdomens shrivel badly, often becoming so distorted as to be identified with difficulty. Alcohol of 75 per cent preserves satisfactorily but the colors are changed and often destroyed.

Stuffing.—All large, plump-bodied specimens should be stuffed, especially in moist climates. This ensures better preservation and much less discoloration, which is often great. Stuffing is done by cutting a slit at one side of the mid-ventral line of the abdomen, carefully removing as much as possible of the soft contents of the body, and tucking in a little roll of cotton or cheese-cloth cut into fine bits with scissors. The cotton may be dusted with dry arsenic or other poisonous or absorptive substance, if desired, with good results. The specimens should then be pinned or packed and dried as rapidly as possible, preferably in a current of air. Rapid drying is essential to prevent discoloration, whether stuffed or not.

Preservative liquids.—Mr. Wm. T. Davis has used very successfully for the preservation of the green color of Katydids, Cone-headed Grasshoppers, etc., a weak solution of formaldehyde (5 per cent). The insects are placed in it at once after capture and remain therein for ten days or longer. They are then removed, pinned, spread if desired, set, and dried. This method has not given satisfactory results with Locusts. Personally, I prefer to inject a few drops of an 8 or 10 per cent solution of formaldehyde with a hypodermic syringe.

Packing.—For packing specimens, while on trips of more than a day's length, shallow pasteboard boxes of sizes suited to the specimens, with covers shutting down (not sliding), are best. Those from a half inch to an inch in depth, and measuring 1 by 2 up to 3 by 5 inches are most convenient and desirable; the plain white 'jeweler's' boxes, sizes 1 to 7, made by the Dennison Co. in assorted sizes and nested together, have proved very satisfactory, and take up little space on the outward trip.

To pack Locusts, have at hand boxes, forceps, scissors, a large awl (sharp-pointed scissors will do), cotton wadding or batting, tissue paper, flake naphthalin, rubber bands, and pencil. Select a box of suitable size to contain the specimens which it is desirable to place together, punch the bottom, top, and sides full of

holes with the awl to allow better circulation of air and more rapid evaporation of moisture; place a layer of specimens on the bottom, heads out, sprinkle among them a little naphthalin to prevent mold and repel vermin, and cover with a layer of good quality cotton cut to fit the box. Cotton wadding is more convenient to use and does not adhere to the specimens so persistently, but sometimes it is not readily procurable in out-of-the-way localities. Two or more layers of insects may be placed in a box but the fewer the more rapidly do the specimens dry out and they then retain their color better. The upper layers may be laid directly upon the cotton covering the lower, but a layer of tissue paper between them facilitates separation when unpacking. Pack until the box is so full that specimens cannot shake about, cover, and tie tightly with thread or slip on a rubber band. On the bottom write place, date, number, and character of specimens and any other desirable data, which will then still be on the box when its cover is removed while dampening.

The boxes thus packed may be placed in an empty net and hung up in the breeze in the shade to dry, or any place in a current of warm, dry air,—over a stove or lamp in emergency. Care must be taken to keep them out of the way of mice, ants, and other vermin. When perfectly dry they may be shipped any distance.

In brief, specimens must be: (1) packed so they cannot shake about; (2) labeled; (3) dried; (4) protected from mold and vermin; (5) protected from crushing during transportation.

If suitable boxes cannot be had, paper tubes may be made as follows: roll a strip around a pencil or other stick of suitable size,—crush in the end, insert the specimen, stuff cotton into the other end to prevent the insect from shaking about and falling out,—if necessary crush in this end also. Write data on outside of tube. This method requires much more time and space than the use of boxes, consequently is suited to relatively small numbers. If more than one specimen is placed in a tube all are likely to be damaged.

Dampening, Pinning, and Spreading.

When ready to mount the specimens, the boxes from each locality or of each lot should be gathered together, the number

of specimens from each noted, and printed labels ordered accordingly; finally, make ready the dampening box. Almost any contrivance will answer, even simply wrapping in wet towels, but the following has proved very satisfactory in practice. Make a wooden box, 12 by 20 inches and 12 inches deep, and line it with zinc or lead, soldered water-tight; make a cover of the same construction shutting down upon rubber around the opening; place in the box a layer of wet sand two inches deep. Strew in a handful of flake naphthalin and set the box in a cool place. If mold appears, renew the sand and naphthalin. The sides and top of unprotected metal or glass containers condense moisture so quickly that their contained atmosphere is drier than desirable.

Remove the covers of a sufficient number of boxes of insects; set the boxes on the sand or on a sheet of paper over the sand and leave for 24 to 48 hours or until sufficiently pliable to be manipulated without injury. The time necessary will depend upon a number of factors—size and character of specimens, temperature, etc. If kept cold mold is not likely to cause trouble; and naphthalin is very useful as at least a partial preventive of mold.

Mounting.—Very small specimens,—*e.g.*, Tridactylus and the smaller species of Nemobius, and early stages of many other species,—are conveniently mounted across the end of a cardboard point mounted on a moderately stout pin. For this purpose use the best thin white bristol-board. Take a strip $\frac{3}{8}$- or $\frac{1}{2}$-inch wide and cut it obliquely across into triangles of about $\frac{3}{32}$-inch base. With the forceps take up a point, dip one side of the tip into alcoholic white-shellac solution, and apply to the left side or underside of the specimen in such a way that when the insect's head is away from you the point is at its right. Let the shellac dry thoroughly and mount on a No. 4 white pin, placing the label on the pin.

For pinning specimens, use a 39-mm. japanned steel pin of the best quality. The mode of pinning varies somewhat with the family. Earwigs, Roaches, and Crickets are best pinned after the fashion of beetles, *i.e.*, through the right wing-cover; so also the Long-horned Grasshoppers and their kin, usually; Phasmids, and Mantids through that part of the body which will best support the strain and carry the weight. Acrididae should be

pinned through one side of the posterior part of the pronotum (metazone)—if properly done, this supports the whole body perfectly and allows the wings of the opposite side to be spread without difficulty. It was Scudder's custom to pin through the right side of the metazone and spread the wings of the left side.

For spreading, the usual board with a deep, cork-bottomed groove is best, on account of the space required for the legs and the frequently crested form of the pronotum. After properly pinning in the groove and arranging the legs, bring the wings forward considerably more than a right angle, until the hind wing is fully expanded. Hold in place with strips of glass or cardboard until dry. For this work the glass-headed black pins sold as 'mourning-pins' are desirable, and strips of window-glass or microscope slides with ground edges. It is usually necessary to spread the wings of but few of a kind, temporarily at least.

At this time also, suitable arrangement of the legs, abdomen, and those parts of the body used in identification should be made if possible. In general, long antennae should be directed backward (but not too high nor too close to the pin) to save space, the parts of the legs slightly separated, and the end of the abdomen exposed to view to facilitate study.

Dampened specimens may be removed from the setting-board in 24 to 48 hours; fresh, unstuffed specimens require 10 to 20 days according to condition of the atmosphere, weather, etc.

Labels, for convenience in handling and study, should be as small as possible but should give the essentials of place and date (State, town, day, month, year) and if more is desirable a 'lot' label may be used, with reference made to a lot-book in which are entered the full history and all details known.

Collections, Cases.

Collections of Orthoptera seem to be especially subject to the attacks of mold and insect pests. For these reasons they should be kept in a dry atmosphere, preferably above the ground floor, and always more than a foot above the floor of the room, the cases charged with naphthalin, and examined frequently. If found to be infested, fumigate, label, and inspect frequently for two years. Fumigation should be done at a temperature of 70° to 90° F., if possible, and with carbon bisulphide at the rate of

3 pounds per 100 cubic feet—carbon tetrachloride and chloroform are not as reliable nor as cheap.

Owing to the weight of the specimens, cases for Orthoptera should be lined with cork, either natural or compressed, because it holds the pins more satisfactorily than any other material. Very large specimens should be steadied by pins placed at the sides of the body. For small specimens mounted on very slender pins, selected peat or pita pith are preferable, allowing the insertion of the pin more readily and with less danger to the specimen.

The Schmitt box is of convenient size for study. A larger case, 15 by 18 inches with a glass cover (the museum type) is desirable for exhibition and when large numbers are to be provided for. My personal collection is arranged chiefly on blocks of compressed cork, and of peat covered with white paper, four and a half by seven and a half inches; 12 blocks (6 by 2) in a wooden tray two inches deep, 12 trays in a metal case whose cover clamps on so tightly as practically to exclude dust, dampness, and insects. This method gives facility of access to a large number at once, convenience of handling in rearrangement and study (a block or tray at a time), and as much safety as practicable. It is not adapted to exhibition nor to examination by unskilled persons.

Packing of pinned specimens.—Whenever it is desirable to ship pinned specimens special pains must be taken to ensure safe delivery. If possible, *don't ship them!*—carry them, or send by some careful hand. In the rough handling to which specimens are subjected by mail and express, heavy specimens are likely to become dislodged and run amuck, laying waste the entire contents of the box; or hind legs fall off and start on a career of their own. To prevent as far as possible such doings,—1st, select a strong, cork-lined box with lining firmly fixed in place; 2d, lay a piece of split cotton wadding, fuzzy side up, on the bottom of the box to entangle wandering members; 3d, pin all specimens firmly into the cork and hold in place with pins crossed over body; and 4th, pack in a large, strong, outer container with plenty of elastic material, such as excelsior, between the two.

I have received and sent pinned specimens by mail with perfect success,—and with no success! I have done the same by express with no better results; but usually, if the packing is correctly

done and the stuffing between the boxes is sufficiently elastic, the results are satisfactory. All shipments, however, are attended with considerable risk of damage or even of total loss, and carriage of valuable specimens in person is advised.

The Orthoptera of New England.

Key to the Families of Orthopteroidea of New England.

A. Abdomen ending in a pair of conspicuous, horny, unjointed pincers or forceps-like appendages, and the tarsi three-jointed. The three pairs of legs similar in form and nearly equal in length. Wings, if present, folded transversely as well as radially and hidden, save at tips, under leathery wing-covers which meet in median line. Dorsum of abdomen exposed posteriorly, horny.

Order Dermaptera, Family *Forficulidae* of authors, p. 283.

AA. Abdomen without forceps-like appendages at end, or if so, with tarsi five-jointed. Wings, if present, folded in fan-like plaits to their base and covered more or less completely by stiffer, parchment-like wing-covers.

Order Orthoptera.

B. Legs equal or nearly equal in size, the hind thighs not distinctly enlarged for leaping. Auditory and sound-producing organs absent. Tegmina (wing-covers) and wings in later nymph stages, when present, in normal position. Ovipositor not conspicuous. Non-saltatorial Orthoptera.

C. Body strongly depressed; broad, often more or less oval in outline. Head nearly or quite concealed by pronotum, the face ventral, the mouth posterior. Pronotum shield-shaped. The three pairs of legs much alike.....Cockroaches, Family *Blattidae*, p. 299.

CC. Body elongate; head freely visible from above.

D. Pronotum elongate. Front legs raptorial, the coxae elongate and thighs enlarged, spinose.

Praying Mantids, Family *Mantidae*, p. 327.[1]

DD. Pronotum short, but little longer than head. All legs similar; coxae not elongate...Walking-sticks, Family *Phasmidae*, p. 321.

BB. Hind legs elongate, the thighs enlarged for leaping. Auditory and sound-producing organs usually present. Tegmina and wings in later nymph stages, when present, reversed in position. Ovipositor usually conspicuous.....Saltatorial Orthoptera.

E. Antennae much longer than the body, bristle-shaped, delicately tapering. Tarsi three- or four-jointed. Ovipositor usually prolonged and compressed, blade-like, or cylindrical and needle-like in form. Auditory organs situated near base of front tibiae, stridulating organs on dorsal field of tegmina.

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[1] Introduced; not established.

F. Tarsi four-jointed. Ocelli usually absent. Tegmina sloping at the sides of the body (except a small area near the base in male). Ovipositor compressed, blade-like, the tip not enlarged.....Katydids, Long-horned Grasshoppers, Cave-crickets, Family *Tettigoniidae*, p. 333.

FF. Tarsi three-jointed. Ocelli variable. Tegmina flat above, bent abruptly down at the sides in both sexes. Ovipositor usually visible as a cylindrical, straight, or up-curved needle-like organ, the tip very slightly enlarged.....Crickets, Tree-crickets, Mole-crickets, Family *Gryllidae*, p. 384.

EE. Antennae shorter than the body, of varied form. Ocelli present. Tarsi usually three-jointed. Auditory organs at sides of base of abdomen. Stridulation produced (in large part) by rubbing the hind thighs against the tegmina. Ovipositor composed of a dorsal and a ventral pair of short, curved pieces moving vertically, with acutely pointed, divergent tips....True Locusts, Short-horned Grasshoppers, Family *Acrididae*, p. 423.

EARWIGS.—Order DERMAPTERA.

The small group of insects popularly called Earwigs and known in scientific terminology as Dermaptera, Euplexoptera, or Forficulidae, at the present time usually given ordinal rank, has been associated in entomological literature so long with the true Orthoptera (Grasshoppers, Crickets, Locusts, etc.) that it seems desirable to treat the New England forms in this Manual.

Earwigs are insects of small or medium size, with direct development, and an elongate body bearing at the hinder end a pair of pincer-like appendages. The metathoracic wings, when present and functional, are membranous for the most part, complexly folded, and nearly covered by the horny mesothoracic wing-covers, which meet in the median line. The legs are short, similar in form, with three-jointed tarsi. The hinder part of the dorsum of the abdomen is exposed and of horny consistency. In their elongate form, exposed abdomen, short legs, abbreviated wing-covers, active movements, avoidance of light, and scavenging habits the Earwigs strikingly resemble the rove-beetles (Staphylinidae) and in consequence are sometimes collected for them by coleopterists. They may be at once distinguished, however, by the forceps-like appendages at the end of the body.

The forceps or pincers are homologous with the cerci of other insects and are characteristic of the group.[1] They are usually more highly developed in the male than in the female and young (in which they are much alike), in some exotic species being of extraordinary size and exceedingly odd form, asymmetrical, or even dimorphic in the same sex. They are used as weapons both of defense and offense;[2] in pairing; and in some cases, at least, as an aid in folding and unfolding the wings. They are characteristically developed even in the wingless species.[3]

[1] In the young of *Diplatys*, from India, the cerci are very long and many jointed, resembling antennae. At the last nymph stage they are abruptly reduced to a single segment.

[2] From personal experience I know that the Maritime Earwig can draw blood with them from human fingers.

[3] This is to be expected; the wings are used only for flight, are more susceptible to environmental influences, and degenerate when not used; while the forceps, employed for several purposes, remain functional.

The metathoracic wings are folded in a complex and characteristic manner: first radially, from a point nearly midway of the front margin, the tip is folded, fan-like, down upon the base; the wings are then tucked away beneath the tegmina, under which they are almost entirely concealed (Fig. 23). There are many wingless forms, and it is said that even the winged species seldom fly. Thus Sharp states: "Though *Forficula auricularia* [the common European Earwig] is scarcely surpassed in numbers by any British insect, yet it is rarely seen on the wing; it is probable that the majority of the individuals of this species never make use of their organs of flight or go through the complex process of folding and unfolding them."

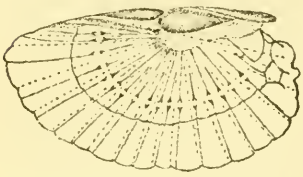

Fig. 23.—Wing of Little Earwig, *Labia minor*. (After Lugger.)

The development is direct and the young resemble the adults, from which they may be distinguished, in the case of the winged species, by the lack of wings and tegmina, whose future presence is indicated in the later nymph stages by radiating ridges on each side of the metanotum. In at least some of the wingless species the number of abdominal segments visible in the young female differs from that in the adult (see *Anisolabis maritima*). Often also the form of the forceps of the young is different from that of the adult, especially in the male.

It is said that the females often outnumber the males. While usually larger, in some cases at least (*e.g., Labidura riparia*) the proportions frequently seem to be reversed. This possibly points to the custom of combat among the males.

The coloration of Earwigs is prevailingly dull, though sometimes prettily varied with yellow and reddish; some exotic species present attractive and even striking colors and patterns of ornamentation, possibly coupled with more diurnal habits. In this connection it is of interest to note that in the winged species the sculpture and texture of the exposed part of the wings usually agree with those of the wing-covers.

A few technical terms, other than those common to other Orthoptera, need explanation. The large plate at the end of the abdomen above is called the *anal plate* or *last dorsal plate;* a

similar one on the under side is the *penultimate ventral segment*, the ultimate showing only as two triangular plates at the sides and behind it. The *pygidium* is a chitinous plate between the bases of the prongs of the forceps, extending downward and sometimes forward; rarely, it is fused with the anal plate (*Labidura riparia*). Attached to its lower (posterior) end is another, the *metapygidium*, which is followed by the *telson* or *supra-anal plate*. These three plates are termed *opisthomeres* and their relative development is a character used in classification. The hinder ones are often greatly reduced in size and visible only with difficulty in dried specimens. Sometimes the last dorsal segment is prolonged backward to form a *squamopygidium* whose hind margin is termed the *anal process* (*Apachyus*, *Dendroiketes*).

The most useful characters for distinguishing species are found in the forceps of the male; indeed, without male specimens the identification of closely allied Earwigs is impossible. The form of the pygidium and that of the last visible abdominal segments perhaps come next in importance; and the characters presented by the tarsi, the proximal segments of the antennae, and the tegmina and wings are much used.

Earwigs are usually secretive during the day, hiding in niches and crannies or under any objects on the ground offering shelter; in the afternoon and evening they become more active, the winged species occasionally flying about freely and sometimes appearing about lights in numbers.

This habit of entering crevices for shelter, combined with their elongate form and crawling, sinuous movements, is very likely responsible in part for their popular name, which is based on the notion that they enter the ears of sleeping persons, an idea which apparently lacks confirmatory facts but which is widely prevalent in Europe and appears in the colloquial name in other languages as well as ours:—*Ohr-Wurm* in German, *perce-oreille* in French.

The food of Earwigs has generally been stated to be vegetable in character, but some species are undoubtedly carnivorous and predatory and probably many will be found, when studied, to be omnivorous. The European Earwig has been reported as sometimes doing considerable damage to the young foliage of hops, clover, etc., and the blossoms of phlox, dahlias, and roses. Others feed largely on living insects, preferably soft-bodied species, and

some are probably scavengers. No Earwigs are known to be truly aquatic but many live in damp places and some species die quickly if deprived of moisture.

The mother Earwig in taking care of her eggs and young shows an attachment rarely exhibited by insects. Thus DeGeer[1] says: "At the commencement of June I found under a stone a female Earwig accompanied by its young. I placed them in a sand-box where I had put a little fresh earth, and it was curious to see how they ran under the stomach and between the legs of the mother, who remained very quiet and allowed them to do it: she seemed to cover them as a hen does her little chicks, and they remained often in this position for hours. The insects of this genus have then, in a kind of manner, care for their young, even after their birth; and they seem to wish to protect them by remaining near them.

"Another time, I found a pile of eggs on which the mother was seated and of which she took the greatest care imaginable without ever moving a step away. I took it with its eggs and placed it in a sand-box half filled with fresh earth, in such a fashion that the eggs were scattered here and there: but soon the mother took the eggs one after the other between her jaws and transported them. After several days I noticed she had got them all together in a like place on the surface of the earth and there she remained constantly seated on them in such a manner that she seemed to cover them."

Our species are few in number, of such inconspicuous habits and local occurrence that observations have rarely been made upon them, and relatively little is definitely known concerning their life histories, seasons, and habits in particular. One of the best papers dealing with a New England species is that by Bennett (Psyche, vol. 11, p. 47–53, June 1903) relating his observations on the habits of the Maritime Earwig at Cold Spring Harbor and in captivity (see p. 290). Probably all of our species could be reared in confinement with little difficulty. The European Earwig also, a recent immigrant of local occurrence, has been studied by government specialists (U. S. Dept. Agric., Bull. 566, p. 1–12).

The student of this order should read the introduction of Burr's Dermaptera in the Fauna of British India (1910). There

[1] Quoted from Burr, in Fauna of British India.

he will find a valuable list of papers and numerous figures. The same author's treatment of the order in the Genera Insectorum is the latest work on its classification and is illustrated with many colored plates, but a preliminary study of the works of Zacher[1] and Verhoeff[2] will be necessary to make it comprehensible. The article by de Bormans in Das Tierreich covers a wide variety of forms and contains many outline cuts of species. A useful résumé of the North American forms, with keys, will be found in the "Notes" of Caudell (Proc. U. S. Nat. Mus., vol. 44, p. 595–599, 1913). The latest article on the North American species of the order is that by Hebard ("Notes on the Earwigs of North America north of the Mexican Boundary," Ent. News, vol. 28, p. 311–323, 1917).

Only six kinds of Earwigs have ever been captured in New England and the occurrence of one of these was purely accidental. Two are introduced species which have maintained themselves for longer or shorter periods in association with man; another is a cosmopolitan species, perhaps of Palaearctic origin, which has established itself at various points on our seashore at high-water mark; another species, scanty in numbers but widely and generally distributed, is regarded as an adventive from Europe; and one,—the common European Earwig,—has established itself at Newport, R. I., and bids fair to become another obnoxious immigrant insect pest.

Measures of control against Earwigs, when needed, are probably to be sought along the lines of depriving them of food and shelter, or by poisoned food, such as the cleaning-up of débris, the use of traps with attractive poisoned baits, possibly also spraying with repellent solutions—kerosene emulsion, formaldehyde, etc. The devices recommended for trapping Roaches would probably be found useful with these insects. (See *Remedies*, p. 266.)

The New England representatives of this order fall into three families, *viz.*: Labiduridae, containing *Anisolabis* and *Euborellia* with one species each (and *Spandex*, adventive); Labiidae, containing *Labia* and *Prolabia*, with one species each; and Forficulidae, with *Forficula*, one species.

[1] Zacher, F. Zool. Jahrb., vol. 30, p. 303–400, 1911.

[2] Verhoeff. See list in Zacher.

It is not advisable to attempt characterization here of either families or genera. The following key aims simply at facilitating identification of the species known from our territory.

Key to Species known from New England,—Adults only.

(See Plate 13, fig. 1–15.)

A. Tegmina and wings absent. Large, dark-colored species.
  B. Antennae tapering, of one color, several of the terminal segments cylindrical, five to six times as long as wide. Femora yellowish. Forceps of male widely separated at base, strongly asymmetric, that of right side much more arcuate than the left, strongly and abruptly widened at base.
    Maritime Earwig, *Anisolabis maritima*, p. 288.
  BB. Antennae filiform, the segments more or less obconic, the distal ones only two or three times as long as wide; usually one to three segments near apex and sometimes also near base pallid. Femora yellowish, usually banded with fuscous. Forceps of male approximated at base, but little asymmetric, the base of the right half not strongly and abruptly broadened in comparison with the left.
    Banded, or Ring-legged Earwig, *Euborellia annulipes*, p. 291.
AA. Tegmina, or tegmina and wings, present. Small or medium-sized species.
  C. Second tarsal segment not prolonged beneath third in side view.
    D. Antennae with fourth segment nearly or quite as long as third. Wings present, exposed behind closed tegmina. Last visible ventral segment of male with pronounced backward-pointing keel-like process.
      Little Earwig, *Labia minor*, p. 292.
    DD. Antennae with fourth segment distinctly shorter than third. Wings absent. Male with last visible ventral segment rounded posteriorly.
      Brown Earwig, *Prolabia arachidis*, p. 293.
  CC. Second tarsal segment expanded distally, cordate, in side view prolonged beneath the third segment.
    European Earwig, *Forficula auricularia*, p. 295.

Maritime Earwig.

Anisolabis maritima (Géné).

Plate 13, fig. 12–14.

Forficula maritima Géné, Ann. Sci. di Regno Lombardo-Veneto, Padova, vol. 2, p. 215 (1832).

Anisolabis maritima Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 43, pl. 7, ♀ (1911).

Antennae 16- to 23-jointed (usually 19 to 20), about one-half as long as body without forceps, luteous at base, deepening gradually

to chestnut or hair brown at tip; tapering, the segments nearly cylindrical, especially toward the tip, and from four to six times as long as wide.

Pronotum nearly square, as wide as head, broadening slightly backward, the front margin straight, hind margin a little convex, hind angles rounded. Hind margin of mesonotum nearly straight, of metanotum strongly concave. No visible trace of tegmina or wings.

Anal plate of male about twice as wide as long, quadrate; of female a little narrower and narrowed behind. Forceps of female and young nearly straight, gently arcuate at tip, the inner margin of the basal half crenulate; of male a little shorter, more arcuate, less finely pointed at tip, and asymmetrical, the right member being more arcuate (curving to 90° with base), and its inner basal process broader, the inner margin faintly denticulate at base.

Blackish mahogany brown, reddish on forceps and edges of terga above and more generally beneath. Legs luteous. Dorsal surface smooth, waxen, minutely punctate. Ventral surface pubescent with sparse, erect, chestnut-brown hairs one-fourth to one-third as long as the segments.

Measurements.

	Body and forceps	Width	Forceps	Antenna
Male	21–28	4.4–7	3–4.5	8–11
Female	20–31	3.8–5.5	4–5.4	9–11.5 mm.

This is our largest Earwig, a squirming, mahogany brown, wingless insect about an inch long, whose unattractive coloring and sinuous crawling movements usually produce a feeling of repugnance in the observer. It lives at or near high-water mark in various localities along the coast, but in the Old World has been reported from elevations of several thousand feet. Walden states that it is found from Maine to Connecticut. It has been reported to me from Gloucester, Marblehead, Lynn, Winthrop, Squantum, and Somerset, Mass.; Newport and Tiverton, R. I.; and at several points on the Connecticut coast, at various dates from May 16 to September 17.

An interesting paper by C. B. Bennett on the habits of this species appeared in Psyche, vol. 11, p. 47–53, June 1904, from which the following account has been condensed.

The Maritime Earwig lives near water and frequently enters it, swimming about freely and hiding beneath floating objects. One remained under water for 65 minutes. It requires a moist habitat and dies if kept in a dry place. In walking over wet earth, the body is dragged on the side, instead of on the broad ventral surface. It is nocturnal, but not exclusively so.

The winter is passed as an adult, rarely in the last nymph stage. Eggs are laid chiefly in July and August, only a very few after the middle of September, in cavities in the ground scooped out by the mouth-parts of the female, usually beneath a log or stone. They are laid in batches of from 25 to 90, sometimes as many as four batches in the course of the summer. The female mounts guard over them until they are hatched, and remains for a few days longer; having once left her custody, the young are in danger of being devoured by the mother if they venture to return.

The eggs hatch in about 17 days.[1] The young resemble the adult, but the legs are spotted and the antennae are proportionally longer. The young female has ten abdominal terga, the adult eight; in the male both adult and immature have ten terga, but the forceps of the young resemble those of the female. The skin is probably shed four times and is usually eaten. The successive stages show no characteristic differences and the length of life is relatively long—one female lived 21 months in captivity. The females are usually larger than the males and appear to be three or four times as numerous.

This Earwig is at least partly carnivorous, feeding on dead or living insects, crustaceans, fishes, etc., and acting as a scavenger on the shore. Both freshly caught and captive individuals refused vegetable food when offered. The forceps were used defensively when attacked, and offensively in capturing living Crickets, sand-fleas, etc., seizing and holding the prey while it was eaten. In hunting, the prey was discovered by the antennae, and instantly seized in the forceps by throwing the body sideways. The forceps were also used in mating, and possibly the difference in the shape of those of the male and female is associated with this function.

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[1] Young 5 to 10 mm. in length were very plentiful at Marblehead Neck, Mass., July 23, 1915.—A. P. M.

Ring-legged Earwig; Banded Earwig.

Euborellia annulipes (Lucas).

Plate 13, fig. 15.

Forficesila annulipes Lucas, Ann. Soc. Ent. France, (2), vol. 5, p. lxxxiv (1847).

Shining pitchy black to reddish chestnut (this last color possibly due to immersion in alcohol?). Antennae filiform, the segments relatively short and obconic, often with from one to three of them near tip and others near base pale luteous or white. Legs luteous; usually, or at least frequently, with the femora banded transversely with fuscous, and sometimes similar bands on the base of the tibiae. Immature specimens are brownish instead of fuscous. The markings of the legs and antennae are by no means reliable as a distinguishing character, being often absent.

Forceps shorter and stouter than in *A. maritima*, in the male less asymmetrical, nearer together at base, the right half less enlarged at base, tapering smoothly, a little more arcuate at tip than the left.

Measurements.

	Body and forceps	Width	Forceps	Antenna
Male	11–14	1.7–3	2	4.5–5
Female	11–16	2.3–3	2.5	5 mm.

This is a smaller species than the Maritime Earwig. The surface of the body sometimes appears more shining, due to less pubescence.

Adults and young of this species were taken at Brighton, Mass., February 1, 1909, in a killing-shed at the Brighton abattoir. Reference has been made elsewhere in this work under another species (*Prolabia arachidis*) to the occurrence of this Earwig and associated insects at this locality and its habits need not be further considered here. Were staphylinid beetles more generally sought by collectors of insects it is probable that additional data would soon accumulate. So far as I am aware, this is the only instance of its capture in New England, but it is a cosmopolitan species and may turn up at any time in any part of our territory in suitable situations. Unlike the Maritime Earwig, it is not restricted to the sea-coast.

Since writing the foregoing, I have seen specimens captured by

Mr. B. H. Walden in Connecticut, while inspecting shipments of plants.

Little Earwig.

Labia minor (Linné).

Fig. 23; Plate 13, fig. 6–9.

Forficula minor Linné, Syst. Nat., ed. 10, vol. 1, p. 423, n. 2 (1758).

Labia minuta Scudder, Boston Journ. Nat. Hist., vol. 7, p. 415 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868); Rept. Ct. Bd. Agric. for 1872, p. 378 (1873).—Burnham, Proc. Manchester (N. H.) Inst. Arts and Sci., vol. 1, p. 47 (1901).

Labia minor Fernald, Orth. N. E., p. 137 (1888).—Scudder, Psyche, vol. 9, p. 99 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 47 (1911).

Antennae 12-segmented, hair-brown, the last two or three segments and sometimes the base pale yellowish brown, the segments subcylindrical or fusiform.

Pronotum as long as head but narrower, rounded posteriorly; tegmina as wide as pronotum and nearly twice as long, obliquely truncate posteriorly. Exposed part of wings half as long as tegmina, rounded postero-laterally. Exposed part of abdomen varying from one-third as long to equal to the tegmina. Hind margin of last dorsal segment of male with a pair of small tubercles near mid-line.

Forceps of male about four-fifths, of female about two-thirds, as long as tegmina, of male widened internally near base by a slight angular process, separated at base by a space nearly equal to their basal width, arcuate, their inner margin roughened by 9 or 10 minute, backward-pointing denticulations; of female a little shorter than in male, flattened at base, attingent throughout, without denticulations. In the male a chitinous, backward-pointing process arises from the middle of the last visible ventral segment, its ventral margin curving gently upward to the tip.

Head and sides of abdomen dark brown, deepening to blackish. Pronotum, tegmina, and exposed wing-tips light to medium-dark hair-brown. Forceps and dorsal median third to half of abdoment chestnut, deepest on forceps, rarely with a transverse dusky cloud midway between tips of wings and base of forceps.

Beneath paler, yellowish brown, palest on legs and base of abdomen, deepening posteriorly to chestnut on apex of abdomen and forceps.

Measurements.

	Body and forceps	Width	Forceps	Antenna
Male	6–7	1–1.3	1.2–1.5	2.3–2.8
Female	5–6	1–1.3	.85–1.2	2.3–2.8 mm.

The Little Earwig is our smallest species and the only one at all generally distributed in our territory, having been found over a large part of the United States. It ranks as a Palaearctic species but whether it entered America in historic or geologic times is unknown. The other species which have been captured in New England are unquestionably importations introduced by commerce, and some apparently maintain themselves for longer or shorter periods only as hangers-on of man. This species pursues an independent existence, though often associating with him.

It is known from all the New England States and has been taken in every month from May 25 to November 4, and under a wide variety of circumstances: from stables, manure-heaps, and fungi; flying about in late afternoon, at dusk, and to lights in the evening. It has been charged with eating the tender corollas of flowers, but it is probably first of all a scavenger and attacks flowers from second choice or in the absence of other food.

Brown Earwig.

Prolabia arachidis (Yersin).

Plate 13, figs. 10, 11.

Forficula arachidis Yersin, Ann. Soc. Ent. France, (3), vol. 8, p. 509, pl. 10, f. 33–35 (1860).

Labia brunnea Scudder, Bull. U. S. Geol. Surv. Terr., vol. 2, p. 257–258 (1876).

Labia burgessi Scudder, Psyche, vol. 9, p. 119 (1900) (erroneous identification by Scudder).

Prolabia arachidis Caudell, Proc. U. S. Nat. Mus., vol. 44, p. 598 (1913).

Size small. Body broad and plump; dark reddish brown, shining with a waxen luster, the abdomen often decidedly chestnut, the pronotum, tegmina, and legs yellowish brown, palest on the

legs. Antennae with eleven segments, brown, segments obconic. Pronotum nearly as wide as head, a little wider than long, its hind margin very slightly convex, hind angles rounded. Tegmina short, but little exceeding pronotum, squarely truncate. Wings absent or not visible. Abdomen three-fourths as wide as long, about equal to rest of body without forceps. Fourth (third visible) tergite with a conspicuous tubercle on each side near hind margin and indication of same on preceding segment. Forceps of male as long as tegmina, sub-arcuate, separated at base by a space equal to width, the inner margin sinuate at base; pygidium of male truncate apically, the corners beveled, the angles slightly denticulate. Forceps of female equal to those of male, straight, arcuate at tip, the inner margins finely crenulate denticulate at base.

Measurements.

	Body and forceps	Width	Tegmina	Forceps	Antenna
Male	7.7– 8.7	8	1.5	2	3–3.5
Female	7.8–10.3	2.5–3	1.5	1.5	3–3.5 mm.

This cosmopolitan species was first taken in New England by Mr. Samuel Henshaw who secured it in numbers in a sugar refinery at Boston on March 30, 1889. Specimens were referred to Mr. Scudder and identified by him as his *Labia burgessi* and later recorded under this name.

On February 1, 1909, I captured several adults and nymphs in the foul basement of a slaughter-house at Brighton, Mass., where they were associated with the Ring-legged Earwig (*q. v.*) and dermestid beetles. All these insects were apparently very much at home in the matted masses of moist and decomposing animal matter, rank-smelling and dust-covered, in close proximity to the hot-water pipes. Here they lived as scavengers or predators, feeding on the unlimited supply of animal substances under conditions which promoted activity at all seasons of the year. A search for them on June 30, 1914, was unsuccessful, the old débris having been removed, but in the small accumulation present at that time species of *Hister* and staphylinid beetles were obtained and *Tenebrio molitor* was not uncommon in the near vicinity.

Burr says that this Earwig "exists in swarms, under artificial conditions, in almost every part of the world."

European Earwig.

Forficula auricularia Linné.

Plate 13, fig. 1–5.

Forficula auricularia Linné, Syst. Nat., ed. 10, vol. 1, p. 423 (1758).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 46 (1911).—Caudell, Journ. N. Y. Ent. Soc., vol. 15, p. 170 (1907).—Jones, U. S. Dept. Agric., Bull. 566, p. 1–12 (1917).

Antennae 11- to 14-segmented, brown, about two-thirds as long as body. Pronotum shield-shaped, front margin straight, sides straight and parallel, rounding smoothly into hind margin which is strongly convex. Tegmina about one and one-third times as long as pronotum; exposed part of wings half as long as tegmina.

Glandular tubercles on sides of terga of abdominal segments 3 and 4 (second and third visible). Anal plate of male twice as wide as long, quadrate, with a pair of low, broad, rounded elevations near hind margin equidistant from margin and mid-line; lateral margins strongly compressed, reflexed upward; hind margin slightly bisinuately convex. Anal plate of female a little narrowed behind, the details of conformation described for the male less pronounced.

Forceps of male arcuate, caliper-like from wide and flat bases; the outer margin sinuate, the inner margin armed at base with several small teeth, a large and prominent one at the quarter or third, directed backward and inward. The males are dimorphic in length of forceps, one series averaging about 4 mm., the other about 7 mm. Forceps of female but little depressed at base, inner margins straight, attingent, the tips a little arcuate, delicately pointed. Forceps of nymph slender throughout, not widened at base, sinuate, less acutely pointed at tip than in the female.

Color varying widely from yellowish to fuscous, usually darkest on the sides of the abdomen and disk of pronotum; the head, legs, and forceps usually paler; the sides of the disk of the pronotum, sides of exposed portion of wings, and variable amounts of the sides and dorsum of pronotum pallid or luteous.

Measurements.

	Body (without forceps)	Width	Forceps	Tegmina	Antenna
Male	10–14	3–4	3.4–4 7 –9	2.5–3	6–9
Female	9.5–14	3–4	3–4 2.5	2.5–3	6–7 mm.

This Earwig has been reported from New York, New Jersey, and Indiana, probably having been introduced with merchandise, plants, or similar materials, but its permanent colonization in any of these States is very much in doubt. Unfortunately, there is no uncertainty concerning its establishment in force at Newport, R. I., where it was first noticed in 1912, and, in 1916, ten square miles were found to be infested, with many outlying colonies. So abundant is it that it has become a decided nuisance by entering houses at night. "On one estate, each morning when the porch awnings were let down, over a quart of earwigs dropped out and were swept up and burned."

In Europe this species is reported as laying its eggs early in the spring. At Newport 75 per cent of captive females laid between November 6 and December 26. The females hibernate in the ground from two to eight inches beneath the surface and attend the young nymphs in the spring. These latter are at first white, gradually become olive green and even steel gray, with nearly transparent legs and a dull-brown head. There are four nymph stages and maturity is reached about July 18.

The young nymphs leave their nests especially on warm nights about two hours after dark. They swarm over the ground within a few feet of the nest and feed on very tender green shoots of clover and grass. Later, they attack Lima bean and dahlia plants, and the flowers of sweet-william and roses, doing great damage. The adults feed largely on flowers but also eat larvae and dead and dying insects, even of their own species.

Late in summer the adults gather in large numbers in the shelter afforded by crevices and vines near a good food supply and mate. The adult males die off in the fall and relatively few females hibernate successfully.

This Earwig has also been recorded from Kingston, R. I. (possibly stragglers from the Newport colony?), and is reported as having been bred from imported brown-tail moth nests at the Gipsy Moth Laboratory at Melrose, Mass. (For remedies, see p. 268 and U. S. Dept. Agric., Bull. 566.)

Spandex sp.

Spandex percheron [sic] Guérin and Percheron. Hebard, Ent. News, vol. 28, p. 323 (1917).

A single example of this genus has been captured in New Eng-

land. The record was based on a badly mutilated specimen in the Harris collection which was described as new by Scudder under the name of *Spongophora bipunctata* (Boston Journ. Nat. Hist., vol. 7, p. 415, 1862). It was later (Psyche, vol. 9, pp. 99, 105, 1900) referred by him to *Forficula percheroni* Guérin and Percheron. The specimen is no longer extant and it is now impossible to ascertain definitely to what species it belonged.

It is recorded as taken May 20, 1827, presumably in Boston or vicinity, and was probably an accidental importation in merchandise from the West Indies or South America.

Two additional native species of Earwigs are recorded from New York State, one believed to be adventive from the south (or mislabeled), and possibly examples may yet be taken in western or southern New England. Adventive specimens of various tropical and subtropical species may be captured at any time in almost any part of our territory.

Synonymy.

Owing to the confusion of species and shifting of names in works bearing on the New England representatives of the order the following partial synonymy is appended for the convenience of the student:

Forficula aculeata Scudder. Scudder, Proc. Davenport Acad. Nat. Sci., vol. 8, p. 5 (1901).—Walden, Orth. Ct., Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 45 (1911) = *Doru aculeatum* Scudder. Not yet known from New England but has occurred in New York and New Jersey.

Forficula percheroni Guérin and Percheron. Scudder, Cat. Orth., Proc. Davenport Acad. Nat. Sci., vol. 8, p. 5 (1901); Scudder, Psyche, vol. 9, p. 99 (1900) = *Spandex* sp.

Forficula pulchella Serville. Scudder, Cat. Orth., Proc. Davenport Acad. Nat. Sci., vol. 8, p. 5, (1901).—Walden, Orth. Ct., Bull. Geol. Nat. Hist. Surv. Ct., no. 11, p. 46 (1911) = *Prolabia pulchella*. Not known from New England.

Labia burgessi Scudder. Scudder, Psyche, vol. 9, p. 119 (1900) = *Prolabia arachidis* Yersin. Specimens wrongly identified by Scudder.

Labia minuta Scudder. Scudder, Nat. Monogr., Boston Journ. Nat. Hist., vol. 7, p. 415 (1862), (orig. desc.).—Smith, Orth. Me., Proc. Portland Soc. Nat. Hist., vol. 1, p. 144, (1868); Orth. Ct., Rept. Ct. Bd. Agric. for 1872, pp. 378, 383(1873).—Burnham, Proc. Manchester Inst. Arts and Sci., vol. 1, p. 47 (1900) = *Labia minor* Linné.

Psalis percheroni Guérin and Percheron. Caudell, Proc. U. S. Nat. Mus., vol. 44, p. 599 (1913) = *Spandex* sp.

Spongophora bipunctata Scudder. Scudder, Boston Journ. Nat. Hist., vol. 7, p. 415 (1862) orig. descr., = *Spandex* sp.

ORDER ORTHOPTERA.

Non-saltatorial Orthoptera.

This group comprises three families which have received as many different group-names in allusion to their different modes of progression or the special adaptations shown by the legs:

Cursoria,—running Orthoptera, Family Blattidae, Cockroaches.

Ambulatoria, or Gressoria,—walking Orthoptera, comprising the Family Phasmidae, Walking-sticks, and the Family Mantidae, Praying Mantes or Mantids. The latter family has also been termed

Raptoria,—from the predatory habits and the special modification of the front legs for seizing prey.

COCKROACHES—Family BLATTIDAE.

Body strongly depressed, more or less oval. Antennae long, bristle-like. Head concealed beneath the pronotum, the face ventral, the mouth posterior. Coxae long and free; legs slender, similar, compressed, the femoro-tibial joint moving in a horizontal plane. When fully developed, the tegmina are parchment-like and overlapping, and the wings membranous, with large anal area; both tegmina and wings are often rudimentary or wanting in the female and sometimes in both sexes.

Cockroaches are prevailingly tropical in distribution, needing heat and moisture, and only three native species are thus far known to inhabit New England. The group appeared very early in geologic time, some representatives as early as the middle Silurian and many in the Carboniferous Age. In all, over 130 species have been described from the Palaeozoic rocks of the United States. Consequently it is a group of great interest to the student of insect palaeontology. "Of no other type of insect can it be said that it occurs at every horizon where insects have been found in any numbers; in no group whatever can the changes

wrought by time be so carefully and completely studied as here; none other has furnished more important evidence concerning the phylogeny of insects" (Scudder).

The Cockroach family is thus one of ancient lineage, though of hopelessly plebeian tastes, and many of its members are, to human eyes, of repulsive appearance and unpleasant associations. Adapted by their flattened form to find ready concealment in crevices, when disturbed they scuttle away on rapid feet, with head hidden beneath their shoulders, into the darkness and protection afforded by near-by cracks and crannies. Omnivorous in diet, they devour with insatiable appetite everything edible that is not too hard or tough for their flabby jaws, and leave defilement wherever they pass.

Endowed as they are with such habits and tastes, it is only natural that some species should have associated themselves with barbaric, hut-dwelling man, become domesticated, and continued with him into civilized dwellings, until they are now all but unknown in the wild state. And these obnoxious vermin afflict man with their presence and depredations in spite of his efforts to be rid of them.

Their biologic relation to man as a purveyor of food and shelter is well shown in a tabular statement of the family as it is found in New England:

Native species, living out-of-doors	3
Adventive North American species	1
Exotic species, living in buildings, fully established but dependent on man	5
Adventive exotic species, occurring accidentally, brought in with articles of commerce in ships, etc.	8
Total	17

The exotic species of adventitious occurrence are, in practically every instance, accidental specimens of tropical and subtropical Roaches which have hidden themselves in merchandise, notably banana bunches and orchids, and have by this means been introduced inadvertently into New England. Fortunately, they fail to establish themselves and become permanent members of our insect fauna owing, it is probable, chiefly to climatic reasons. It is likely that many other species of similar habits and distribution will be reported from time to time, in consequence of similar

accidental importations. It would obviously be incorrect to regard such waifs and strays as an essential part of the New England fauna, and unnecessary and out of place to include them here except briefly. For this reason the Key to Species aims to cover only those which are known to exist here naturally or to have maintained themselves for longer or shorter periods of time.

The number of generations of these insects per year appears to differ with the species. Of the wild, native Roaches there is but one brood; of the German Roach or 'Croton-bug' there are several, according to latitude; and the Oriental Roach is believed to require several years to reach maturity. The eggs are usually laid, several at a time, enclosed in a horny, bean-shaped capsule called an oötheca (o-o-thé-ca) which is carried about for several days protruding from the body of the female, and is finally dropped apparently at random in the haunts of the adult. The capsule opens along one side (in some species the inner, in others the outer side) by a seam. The young are said to secrete a liquid which dissolves the cement and allows them to emerge by pressing apart the lips of the seam. Some species are reported to be viviparous. It is said that the female in certain instances aids the young to escape.

The sexes may generally be distinguished without difficulty, though there is no visible ovipositor. The males are characterized in most genera, in addition to the conspicuous cerci, by the presence of a pair of styles. These are placed at the sides of the hind margin of the last ventral segment of the abdomen. The females of some genera have the last ventral segment cleft by a median fissure, dividing it into obliquely sloping right and left valves.

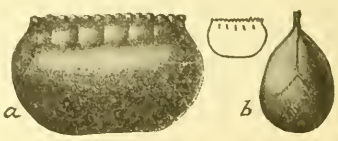

Fig. 24.—Egg capsule of *Periplaneta americana*. *a*, side; *b*, end view. Natural size indicated by outline figure. (After Marlatt.)

Roaches are nocturnal insects, remaining quiet by day in the sheltering darkness of their abode. At night they sally forth seeking food, and attack everything edible, especially such articles as contain starch. Wall-paper, clothing, book-bindings, etc., are subject to their depredations as well as ordinary food stuffs, and the aggregate damage is very heavy, particularly in warm

climates. "The damage they do is not only in the products actually consumed, but in the soiling and rendering nauseous of everything with which they come in contact. They leave, wherever they occur in any numbers, a fetid, nauseous odor, well known as the 'roachy' odor, which is persistent, and cannot be removed from shelves and dishes without washing with soap and boiling water. Food supplies so tainted are beyond redemption. This odor comes partly from their excrement, but chiefly from a dark-colored fluid exuded from the mouth of the insect, with which it stains its runways, and also in part, doubtless, from the scent glands, which occur on the bodies of both sexes between certain segments of the abdomen, and which secrete an oily liquid possessing a very characteristic and disagreeable odor. It frequently happens that shelves on which dishes are placed become impregnated with this roachy odor, and this is imparted to and retained by dishes to such an extent that everything served in them, particularly liquids, as coffee or tea, will be noticed to have a peculiar, disgusting, foreign taste and odor, the source of which may be a puzzle and will naturally be supposed to come from the food rather than from the dish" (Marlatt).

Remedies for Roaches in dwellings are innumerable, but few are effective and satisfactory. Aside from closing up and fumigating the entire premises with hydrocyanic-acid gas (a deadly poison, consequently dangerous and inconvenient to use), dusting the haunts of the insects with powdered sodium fluoride is perhaps as effective as any means of keeping the household species in check.[1] Glass jars laid on the side and baited with banana peel or molasses, the mouth closed by thrusting into it a paper cone with opening wide enough for entrance of the Roaches, have been used with good results, sometimes capturing them alive in considerable numbers. Poisoned paste, pyrethrum powder, powdered borax and chocolate, plaster-of-paris and flour (one part to four) with water placed near by, are other remedies frequently used. "Rather than put faith in half of those which have been published, it were better to rely on the recipe . . . current among the Mexicans: *To get rid of Cockroaches*,—Catch three and put them in a bottle, and so carry them to where two

[1] Farmers' Bulletin no. 658, U. S. Dept. Agric.

roads cross. Here hold the bottle upside down, and as they fall out repeat aloud three *credos*. Then all the cockroaches in the house from which these three came will go away" (Blatchley,

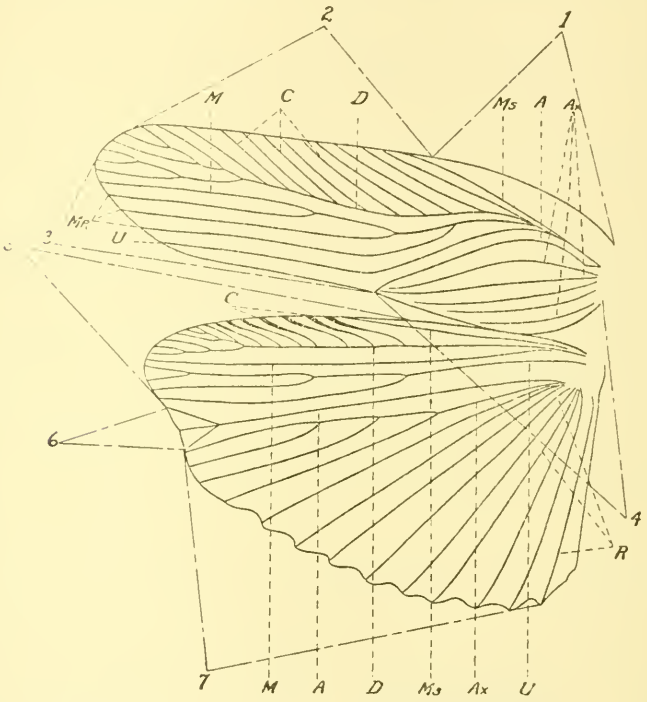

Fig. 25.—Diagram of the fully developed tegmen and wing of a Blattid.

1. Marginal field.
2. Scapular field.
3. Discoidal field.
4. Anal field.
5. Anterior field.
6. Intercalated triangle.
7. Posterior field.

A—Anal sulcus.
Ax—Axillary vein.
C—Costal veins.
D—Discoidal vein.
M—Median vein.
Mr—Branches of median vein.
Ms—Mediastine vein.
R—Radiate veins.
U—Ulnar vein.

In species where the area here represented by the Intercalated Triangle is more extensive and reflexed, it is termed the Appendicular Field. (From Hebard, Blatt. N. A., and Trans. Amer. Ent. Soc., vol. 42, 1916.)

from Janvier). Possibly this treatment might not be effective in New England.

The student of our Roaches needs a copy of Hebard's work,

"The Blattidae of North America north of the Mexican Boundary" (Mem. Amer. Ent. Soc., no. 2, 1917). This is an indispensable guide to the study of our members of this group of Orthoptera. A text-figure explains the terms used in connection with the venation of tegmina and wings, and ten plates of illustrations present numerous entire figures and many diagnostic details of structure. It contains also extensive data on distribution and many bibliographical references. For this reason the bibliographical references cited below are reduced to a minimum.

Taxonomically, the family Blattidae is split up into a large number of subfamilies, varying with different authors from 11 to 16. Of about seven recognized from North America, representatives of four have been taken in New England. All but one of the species definitely known to be established in New England belong to the Blattinae (including Periplanetinae of some authors). The following key includes all established species but omits some of the adventive visitants captured every now and then as escapes from merchandise of tropical origin.

Key to Species of Blattidae.

(See Fig. 26–33.)

A. Middle and hind femora armed beneath on one or both edges of posterior (ventral) margin with two or more distinct spines.

B. Pronotum and tegmina clothed with microscopic silky pile. Large species, pronotum 12 to 14 mm. wide. Adventive.....Subfamily NYCTIBORINAE.

C. A conspicuous yellow stripe covering front and side margins of pronotum and extended on basal two-fifths of costal margin of tegmina, narrowed in front and tapering to a point posteriorly on the tegmina and margined exteriorly by a dark line of the ground color. Otherwise brownish fuscous, the tegmina brownish fuscous at base, grading to deep golden brown at tip. Apparently glabrous; the pile microscopic, invisible without lens.

Yellow-striped Silky Roach, *Nyctibora laevigata*, p. 319.

CC. No yellow on pronotum or tegmina; the latter golden brown; pile longer, visible without lens...Silky Roach, *Nyctibora noctivaga*, p. 319.

BB. Pronotum and tegmina without pile.....Subfamily BLATTINAE.

D. Large species; pronotum of female at least 9 mm. wide.

E. Tegmina covering abdomen or exceeding it.

F. Supra-anal plate in both sexes much exceeding sub-genital plate, with deeply cut hind margin (Fig. 26). Color castaneous, with obscure yellowish markings on pronotum.

American Roach, *Periplaneta americana*, p. 312.

FF. Supra-anal plate not exceeding subgenital plate, its hind margin divided in ♀, squarely truncate in ♂ (Fig. 27). Costal margin of tegmina at base and disk of pronotum sharply marked with yellow.....Australian Roach, *Periplaneta australasiae*, p. 314.

EE. Tegmina abbreviated.

G. Arolia very small. Roaches of medium size; tegmina of female lateral, sub-triangular, scale-like; in male normal but covering only two-thirds or three-fourths of abdomen (Figs. 33, 41). Uniform dark reddish brown. Pronotum 6.5 to 9 mm. wide.

Oriental Roach, *Blatta orientalis*, p. 315.

GG. Arolia large, fully half as long as claws. Pronotum 13 to 16 mm. wide. Very large adventive species with tegmina rudimentary in both sexes.....*Eurycotis* spp.

DD. Medium or small species. Pronotum of female not over 7 mm. wide; of male, less.

H. Pronotum marked with two longitudinal fuscous stripes. A small species, in buildings, etc. (Fig. 38).

German Roach, *Blattella germanica*, p. 310.

HH. Pronotum brown, margined laterally (sometimes anteriorly) with yellow, which is continued on the costal margin of the tegmina (Figs. 29, 30, 36, 37). Usually found out-of-doors.

Pennsylvania, or Bicolored Wood-roach, *Parcoblatta pensylvanica*, p. 308.

HHH. Uniformly colored or nearly so; disk of pronotum often dusky in center. Out-of-door species.

I. Female with tegmina much reduced, narrowly triangular with rounded apex, usually separated on mid-line by a space one-third to one-half their width (Figs. 31, 35). Supra-anal plate of male convex posteriorly. Male yellowish brown; female blackish chestnut, very dark.

Uhler's Wood-roach, *Parcoblatta uhleriana*, p. 307.

II. Female with tegmina covering two-fifths to one-half of the abdomen, broad, meeting in mid-line (Fig. 32). Supra-anal plate of male produced, broadly triangular with rounded apex. Male yellowish brown; female chestnut-colored.

Common, or Northern Wood-roach, *Parcoblatta virginica*, p. 306.

AA. Middle and hind femora not armed as above.

J. Prevailing color brown, tegmina pale, pronotum dark. Anterior margin of pronotum and base of costal margin of tegmina yellow. Nymphs with posterior half of abdomen rough above.

Surinam Roach, *Pycnoscelus surinamensis*, p. 317.

JJ. Prevailing color green. Adventive.....Green Roaches, *Panchlora* spp.

Native Species.

Our native Roaches belong to the genus *Parcoblatta*, but until very recently were called *Ischnoptera*. There are about a dozen species in North America, and at least three in New England. The males of this genus have fully developed tegmina and wings, much longer than the body; in the females these organs are much reduced, in one of our species covering only three-quarters or two-thirds of the abdomen. In two others the wings are wanting and the tegmina are mere functionless scales covering the base of the abdomen.

This great diversity in the development of these organs, combined with the lack of specimens in series and especially the lack of definite data regarding the relationship of the winged and wingless forms, has made these insects for a long time a veritable stumbling-block for the systematist. Hebard, in a recent work on the North American Roaches, based on the largest series of specimens ever brought together, has brought an approach to order out of chaos. While there is still much to be learned, many tangled knots of nomenclature and synonymy have been unraveled.

26 27 28 29

Fig. 26.—American Roach, *Periplaneta americana*. End of abdomen of male. (After Hebard.)
Fig. 27.—Australian Roach, *Periplaneta australasiae*. End of abdomen of male. (After Hebard.)
Fig. 28.—Uhler's Wood-roach, *Parcoblatta uhleriana*. Dorsal outline of supra-anal plate of male. (After Hebard.)
Fig. 29.—Pennsylvania Wood-roach, *Parcoblatta pensylvanica*. Dorsal outline of supra-anal plate of male. (After Hebard.)

Active chiefly by night, like other Roaches, the males are attracted to lights, and sometimes come to trap-lanterns in numbers; the females, unable to fly, must be sought in their haunts: under bark of dead trees and logs, under stones, boards, etc., lying on the ground;—or they may be trapped by sinking fruit-jars baited with molasses or banana peel into the ground level with their tops, when the Roaches, attracted by the odor, fall in

and are drowned or may be taken out from time to time. In order correctly to associate the winged and wingless forms of a locality the two methods of capture (trap-lanterns and baited jars), should be used together.

Only one of our native Roaches has been reported as infesting houses in numbers.

Common or Northern Wood-roach.

Parcoblatta virginica (Brunner).

Fig. 32.

Temnopteryx virginica Brunner, Nouv. Syst. Blatt., p. 86 (1865), ♀.
Ischnoptera borealis Brunner, Nouv. Syst. Blatt., p. 133 (1865), ♂.—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 162 (1911).

Male: pale yellowish brown or tawny above and beneath; the disk of the pronotum sometimes showing a darker central spot. Female: legs, pronotum, and tegmina brownish yellow or tawny, darkest on pronotum and tegmina; abdomen brownish fuscous with a yellowish tinge.

Measurements.

	Total		Pronotum		Tegmina		Antenna
	Length	Width	Length	Width	Length	Width	
Male...	15.5–20	6.5–7	2.8–3.4	3.7–4.4	13–15	4–5	15–18
Female..	10 –12.5	5 –6	3.2–3.5	4.2–4.5	3.8–4.5	3–3.5	9–10.5 mm.

This is our smallest native Roach. The males fly freely to light. Mr. E. J. Smith of Sherborn, Mass., captured more than

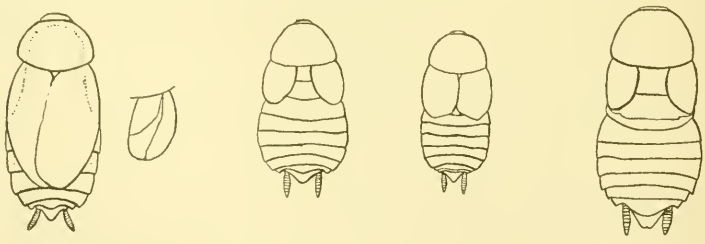

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Fig. 30.—Pennsylvania Wood-roach, *Parcoblatta pensylvanica*. Variation in size of tegmina of female. (After Hebard.)
Fig. 31.—Uhler's Wood-roach, *Parcoblatta uhleriana*. Outline of female. (After Hebard.)
Fig. 32.—Common Wood-roach, *Parcoblatta virginica*. Dorsal outline of female. (After Hebard.)
Fig. 33.—Oriental Roach, *Blatta orientalis*. Dorsal outline of female. (After Hebard.)

twenty one season in the month of June in a trap lantern set for moths. Other examples in my collection come from Framingham (C. A. Frost), North Wilmington, and Wellesley, Mass., and were taken between June 4 and 22. The females I have found under loose stones, boards, and other débris lying on the ground, beneath loose bark, etc., between June 4 and July 27 in eastern Massachusetts, and on August 10 at Hartland, Vt. I have also seen specimens taken between these dates at Orono, Me., and New Haven, Ct. Hebard reports it from as far south as North Carolina and Alabama, and west to Minnesota and Kansas.

Uhler's Wood-roach.

Parcoblatta uhleriana (Saussure).

Figs. 28, 31, 34, 35.

Ischnoptera uhleriana Saussure, Rev. et Mag. Zool., ser. 2, vol. 14, p. 169 (1862).—Scudder, Psyche, vol. 9, p. 100 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, pp. 55, 162 (1911).

Ectobia lithophila Scudder, Boston Journ. Nat. Hist., vol. 7, p. 417 (1862).

Ischnoptera johnsoni Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 162 (1911).

Platamodes unicolor Scudder, Boston Journ. Nat. Hist., vol. 7, p. 417 (1862). —Fernald, Orth. N. E., p. 137 (p. 53 of sep.) (1888).

The males of this species are very similar to those of *P. virginica* but average slightly broader. The females are very dark, almost piceous in color, slightly paler on the lateral margins of the pronotum and tegmina. The characters presented by the tegmina in the females and the supra-anal plate in the males readily distinguish the two species.

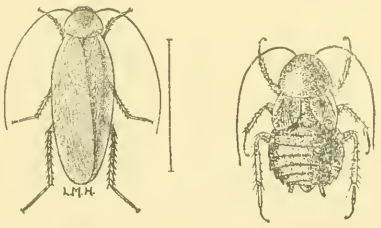

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Fig. 34.—Uhler's Wood-roach, *Parcoblatta uhleriana*. Male. (After Lugger.)

Fig. 35.—*Parcoblatta uhleriana*. Female one and one-third times natural size. (After Blatchley.)

This little Roach is less common in New England and more southern in its range than *P. virginica*. It has been reported from the vicinity of Boston, Mass., west to Michigan and Iowa, and south to Florida and Alabama. In habits it is apparently similar to *P.*

virginica, the males coming to lights, and the females to molasses traps, and both sexes frequent the same places. I have seen New England examples from Middlesex Fells, Sherborn, and Wellesley, Mass.; Lyme, and New Haven, Ct., and also a female from Edgartown, Martha's Vineyard, taken by Mr. C. W. Johnson.

Bicolored Wood-roach; Pennsylvania Wood-roach.

Parcoblatta pensylvanica (DeGeer).

Figs. 30, 36, 37.

Blatta pensylvanica DeGeer, Mém. Hist. Ins., vol. 3, p. 537, pl. 44, fig. 4 (1773).

Ectobia borealis Beutenmüller, Bull. Amer. Mus. Nat. Hist., vol. 6, p. 261 (1894).

Blatta flavocincta Scudder, Boston Journ. Nat. Hist., vol. 7, p. 417 (1862). —Fernald, Orth. N. E., p. 135 (51 of sep.) (1888).

Ischnoptera pensylvanica Scudder, Psyche, vol. 9, pp. 99, 119 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 54 (1911).

Phyllodromia borealis Scudder, Psyche, vol. 9, p. 100 (1900).

Platamodes pensylvanica Scudder, Boston Journ. Nat. Hist., vol. 7, p. 417 (1862).

General color chestnut to dusky chestnut; the disk of the pronotum on the sides, sometimes on the front, and the costal margin of the tegmina on the basal half or two-thirds whitish yellow.

Measurements.

	Total length	Tegmina	Pronotum		Hind tibia	Antenna
			Length	Width		
Male.....	25–28	22–23	4.4–5.4	5.7–7	8–9	24–28
Female.....	16–19	9–11	5–6	6–7	6–6.5	18–20 mm.

This species may be readily distinguished from our other New England forms by the yellow markings of the pronotum and tegmina, and in the female by the extent of the tegmina which cover two-thirds or more of the abdomen.

It seems to be rare in eastern New England, very few specimens having been recorded. Hebard reports it from Prout's Neck, Me., and Winthrop, Mass.; Walden from Mt. Carmel, Ct., June 18, July 10. I have a nymph, May 2; a female taken under burlap by E. J. Smith, no date; and a male, June 21, taken by C. A. Frost, all from Sherborn, Mass. On July 9, 1904, males,

females, and young were present in large numbers on the shore of Grand Isle in Lake Champlain, Vt., under fragments of rock and boards in the near vicinity of camp cottages. Blatchley says that it is the commonest native Roach in Indiana, where adults may be taken from May 5 till October. "As the long-winged males are attracted by light, country houses are often badly infested with them; and where food is scarce, the wall paper is sometimes much injured for the sake of the paste beneath. What the hordes of young which dwell under the bark of logs live upon is a question as yet unsettled, but the larvae of other insects undoubtedly form

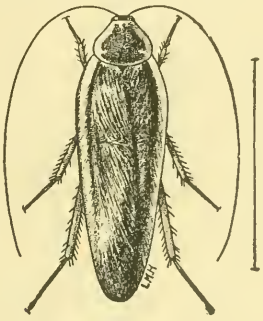

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Fig. 36.—Pennsylvania Wood-roach, *Parcoblatta pensylvanica*. Male. (After Lugger.)
Fig. 37.—*Parcoblatta pensylvanica*. Female. (After Blatchley.)

a portion of their food, as in two instances I have found them feeding upon the dead grubs of a *Tenebrio* beetle; while living as well as decaying vegetable matter probably forms the other portion. The mating of the imagoes probably occurs in late spring or early summer, the newly hatched young being most abundant from mid-August until December. Females with oötheca protruding have been taken as early as May 19th and as late as September 3d. The young in various stages of growth survive the winter in the places mentioned, they being the most common insects noted in the woods at that season. Cold has seemingly but little effect upon them, as they scramble away almost as hurriedly when their protective shelter of bark is removed on a day in mid-January with the mercury at zero, as they do in June when it registers 100° in the shade" (Blatchley).

Established Exotic Species.

German Roach; Croton-bug; Water-bug.

Blattella germanica (Linné).

Fig. 38.

Blatta germanica Linné, Syst. Nat., ed. 12, p. 668 (1767).—Fernald, Orth. N. E., p. 134 (50 of sep.) (1888).—Scudder, Psyche, vol. 9, p. 100 (1900).—Scudder, Boston Journ. Nat. Hist., vol. 7, p. 418 (1862).

Ectobia germanica Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868); Rept. Ct. Bd. Agric. for 1872, pp. 378, 383 (1873).

Phyllodromia germanica Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 379 (1874).—Beutenmüller, Bull. Amer. Mus. Nat. Hist., vol. 6, p. 258 (1894).

Blattella germanica Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 56 (1911).

Color: light buffy brown, the female nymphs sometimes much darker, almost castaneous. The disk of the pronotum with a pair of fuscous longitudinal stripes separated by a space a little greater than their width.

Measurements.

Total length	Tegmina	Antenna
12–14	10–11	13–15 mm.

Male and female are of practically the same size, the female a little broader.

The German Roach is a native of Europe, but owing to its predilection for the society of man as a provider of the necessities

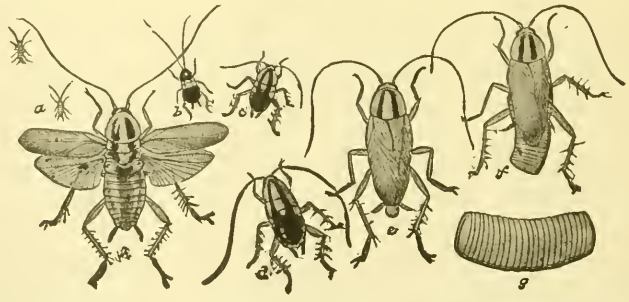


Fig. 38.—The German Roach, *Blattella germanica*. *a*, first stage; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, adult; *f*, adult female with egg case; *g*, egg case, enlarged; *h*, adult with wings spread. All natural size except *g*. (After Riley.)

and luxuries of life, it has become cosmopolitan. It is our smallest species but makes up in numbers what it lacks in size—as is

customary. It received its American name of Croton-bug because of its rapid spread in New York City simultaneously with the introduction of the Croton water service, and its presence is to be expected in every city and town with a community water-supply; and in many without, where conditions are favorable for its existence.

A lover of heat and moisture, possessing the instinct to hide and the ability to insinuate itself into exceedingly narrow crevices; with a special liking for food of a starchy nature which is everywhere available in association with man, it takes advantage of the presence of steam- and water-pipes to gain access to all parts of buildings, particularly to those where food may be readily secured. It travels wherever man carries merchandise, and unceasing vigilance and persecution are often not enough to exterminate it, once it has taken possession of favorable quarters.

Blatchley in his "Orthoptera of Indiana" gives an excellent account of this species, from which the following remarks are quoted: "It seldom if ever occurs in numbers in the country, but is one of the worst insect pests with which the inhabitants of the larger cities . . . have to deal. It is the most fecund of all the roaches and the seasons of mating and hatching of the young are, perhaps, more irregular than in any other species. Adult forms are . . . to be found at all seasons of the year. . . . Where it once obtains a foothold and the surroundings of temperature and food supply are favorable, it is almost impossible to eradicate, as its small flattened form enables it to hide and breed in cracks and crevices which none of the other roaches can enter.

"Like many other omnivorous animals, Croton-bugs find in wheaten flour a food substance which is rich in nutrition and easily digested, and so they prefer wheat breads and starchy materials to all other foods. On account of this liking they often do much harm to cloth bound books by gnawing their covers in search of the paste beneath. They also seem to have a peculiar liking for paints of various kinds, and in the office of the U. S. Coast and Geodetic Survey, at Washington, have done much damage

by eating off the blue and red paints from the drawings of important maps. Glover . . . states that in his office 'They made a raid on a box of water colors where they devoured the cakes of paint, vermilion, cobalt and umber alike; and the only vestiges left were the excrements in the form of small pellets of various colors in the bottom of the box.'

"The oötheca of the Croton-bug is very light brown, a little over twice as long as broad, 7.5x3.5 mm., with the sides somewhat flattened and the edges parallel. Within it the eggs, thirty-six in number, are arranged in the usual two rows. It is carried about by the mother roach for several days with from half to three-fourths of its length protruding from the abdomen, and when dropped in a favorable place the young, evidently very soon, emerge from it; for in a bottle in which a female with protruding oötheca was placed at eleven o'clock P. M. the young were found to have emerged on the following morning at eight. They were then wholly white, except the lateral edges of the abdomen, where a blackish tinge was evident. By five o'clock in the afternoon of the same day, having meanwhile eaten their fill of moistened wheaten bread, they had become too large for their skins, and had moulted for the first time. They then measured 3 mm. in length, and the head, pronotum, abdomen, and apical half of antennae were black, while the other two thoracic rings and the basal half of antennae were a grayish white. The half grown young are very dark brown, with the first four or five segments bordered with yellow, and with traces of a lighter median stripe."

American Roach.

Periplaneta americana (Linné).

Figs. 26, 39.

Blatta americana Linné, Syst. Nat., ed. 10, vol. 1, p. 434 (1758).

Periplaneta americana Scudder, Boston Journ. Nat. Hist., vol. 7, p. 416 (1862); Psyche, vol. 9, p. 100 (1900).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 383 (1873).—Fernald, Orth. N. E., p. 135 (p. 51 of sep.) (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 58 (1911).

Castaneous, the disk of the pronotum lightest, with hind mar-

gin fuscous, and usually a castaneous or fuscous bilobed spot in the center, but sometimes nearly solid-colored in the female.

Measurements.

	Total	Tegmina	Pronotum		Hind tibia	Antenna
			Length	Width		
Male.....	34–37	28–32	8–10	9.5–10.5	11–13	40–57
Female.....	30–33	25–26	8– 9	10 –11.5	12–12.5	35–38 mm.

This is our largest common Roach and it finds a congenial abiding-place wherever organic débris accumulates in quantity accompanied by heat and moisture. Consequently it sometimes exists in enormous numbers in slaughter-houses, sugar-refineries, breweries, and restaurants of the lower class, where it is frequently

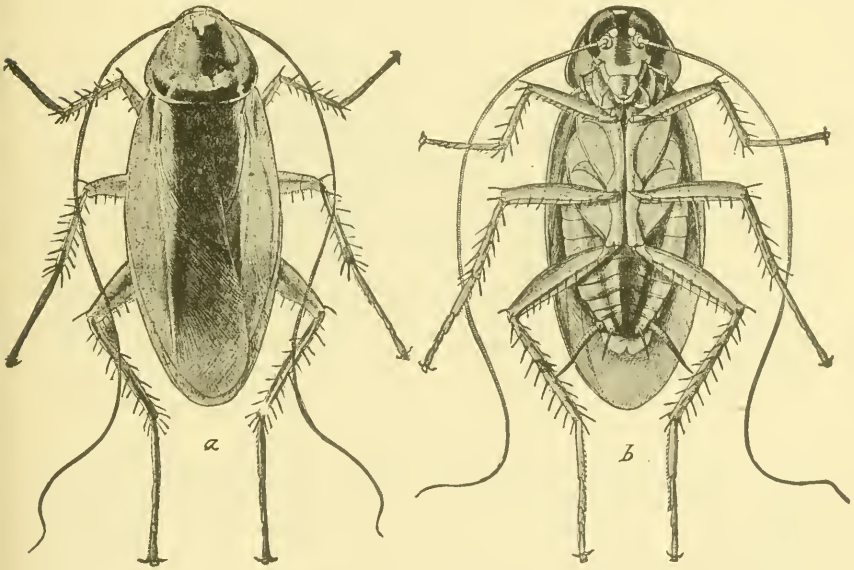


FIG. 39.—The American Roach, *Periplaneta americana*. *a*, view from above; *b*, from beneath. Both enlarged one-third. (After Marlatt.)

associated with the Oriental Roach and the German Roach or Croton-bug. In such places it hides in cracks and dark filthy corners, in closets and under floors, often gathering in large groups, surrounded at times by the new-born young and the

immature in all stages of development, awaiting the quietness of night to come out and search for food.

Able to run swiftly on its long legs and fly freely with its ample wings, but chiefly through its association with man and his commerce, it has spread around the globe and established itself wherever continuous heat, moisture, and food are to be found. A native of tropical or subtropical climates, it probably does not maintain itself in New England except under artificial conditions, but it has been reported from various points and probably inhabits every city and large town in the district.

Australian Roach.

Periplaneta australasiae (Fabricius).

Figs. 27, 40.

Blatta australasiae Fabricius, Syst. Ent., p. 271 (1775).
Periplaneta australasiae Scudder, Psyche, vol. 9, p. 119 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 59 (1911).

Dark castaneous, less dark toward end of tegmina, and deepening to black on head and pronotum. Base of tegmina on costal margin (in front of mediastinal vein) marked with bright yellow. Disk of pronotum black or dark castaneous, the narrow, dark margin bordered internally by a more or less continuous pale yellow ring, which is widest behind (where also the dark margin is widest), sometimes discontinuous, and sometimes extended on the mid-line.

Measurements.

	Total length	Tegmina	Pronotum		Hind tibia	Antenna
			Length	Width		
Male.....	33	27–28	6	8.5– 9	10.5–11.5	35–42
Female.....	29–32	24–25	8	10 –10.5	11– 12	26–28 mm.

The Australian Roach is a little smaller than its relative, *P. americana*, and is even attractive in its brightly contrasted coloring. It is likewise an introduced species, living here only under artificial conditions. In the South it is said to be even more plentiful and destructive than *P. americana*, but it is less generally distributed in New England. Walden records it from New Haven

and Wallingford, Ct., and it has been taken at Orono, Me. Several years ago it was present in some numbers in a conservatory at Wellesley, Mass., where together with the Surinam Roach, it was

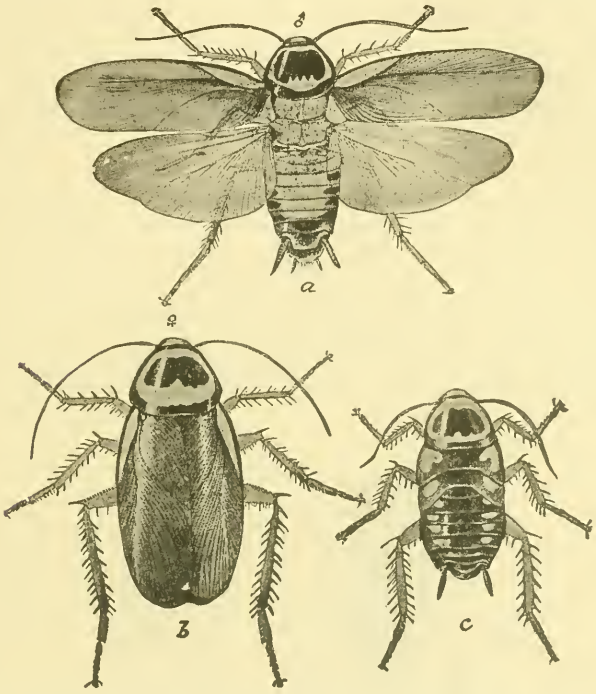


Fig. 40.—The Australian Roach, *Periplaneta australasiæ*. *a*, male with spread wings; *b*, female; *c*, pupa. All life size. (After Marlatt.)

particularly obnoxious by gnawing the tender, growing tips of the aërial roots of orchids. Trapping and poison exterminated both species in a short time.

Oriental Roach.

Blatta orientalis Linné.

Figs. 33, 41.

Blatta orientalis Linné, Syst. Nat., ed. 10, vol. 1, p. 434 (1758).—Harris, Treatise, 3d ed., p. 145, fig. 66, ♂ (1862).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 57 (1911).

Periplaneta orientalis Fernald, Orth. N. E., p. 136 (p. 52 of sep.) (1888).

Stylopyga orientalis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 416 (1862).—Scudder, Psyche, vol. 9, p. 100 (1900).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868); Rept. Ct. Bd. Agric. for 1872, p. 383 (1873).

Color: very dark mahogany brown, the female nearly black, shining.

The New England material which I have seen is limited and the measurements given below will probably need correction to cover extremes.

Measurements.

	Total length	Tegmina	Pronotum		Hind tibia	Antenna
			Length	Width		
Male.....	21.5–25	12–16	6	7.5–8.5	9–10.5	
Female...	20– 28	4– 5.5	6.5–7.5	9– 10	9– 9.5	20–22 mm.

The Oriental Roach is a native of the Far East but has become cosmopolitan through the agency of commerce, and established itself throughout the world in suitable conditions. It is probably

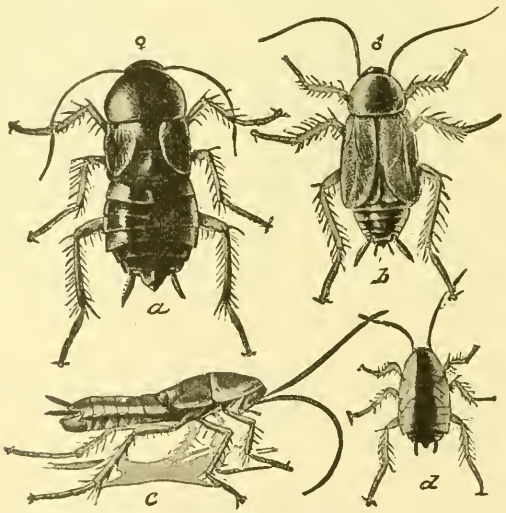


Fig. 41.—The Oriental Roach (*Blatta orientalis*). *a*, female; *b*, male; *c*, side view of female; *d*, half-grown specimen. All natural size. (After Marlatt.)

widespread in the cities and large towns of New England, but personally I have found it less abundant than *P. americana*. "It delights in filth and darkness, and hence in the holds of vessels, the cellars and basements of tenement houses, and in all damp,

dirty places it swarms by thousands, undoubtedly doing much good as a scavenger, but infinitely more harm on account of its omnivorous and insatiable appetite. Like most other members of the family, it feeds mainly at night, appearing to detest and avoid the light, as one can readily prove by taking a lighted lamp suddenly into its haunts, when a hurried scrambling will take place towards its daylight retreats, and but a few moments will elapse before the last of the busy marauders will have disappeared. . . .

"The Oriental roach is probably the most carnivorous of all our Blattidae, though, like most others, it is fond of starchy food. It is known to feed upon cheese, meat, woolen clothes, and even old leather, and is said to be especially fond of the festive 'bed-bug,' . . . which soon disappears from a house infested with the Oriental roach. This roach is, however, far too great a nuisance in itself to be introduced as a means of eradicating even the bed-bug" (Blatchley).

Surinam Roach.

Pycnoscelus surinamensis (Linné).

Blatta surinamensis Linné, Syst. Nat., ed. 12, vol. 1, p. 687 (1767).
Leucophaea surinamensis Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 53 (1911).
Pycnoscelus surinamensis Scudder, Psyche, vol. 9, p. 100 (1900).
Pycnoscelus obscurus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 422 (1862).

Posterior edge of the lower margin of the middle and hind femora sparsely set with hairs; front edge of lower margin of front femora with a denser row of shorter bristle-like hairs. Hind edge of pronotum obtuse-angulate with rounded apex. Glabrous, the disk of pronotum finely punctate, shining. Smoky or olive brown, the disk of the pronotum darkest, but often with a more or less chestnut tinge centrally; the nymphs uniformly dark, the adults with the antero-lateral margins of the pronotum and basal part of costal margin of tegmina dull yellow.

Measurements.

	Total length	Tegmina	Hind tibia	Pronotum		Antenna
				Length	Width	
Female.....	19–21	15	5	6.5–7	4.2–5	9 mm.

(Males are unknown from the continent of North America.)

The nymphs of this Roach may be readily recognized by the dull, roughened, tuberculate surface of the posterior half of the abdomen, in contrast with the shining piceous surface of the anterior part of the body. The hind margin of the pronotum in the adult is distinctly produced and sub-angulate, a character which, with its short oval form, at once distinguishes it from our other species.

The Surinam Roach is another of the introduced exotic species which has gained entrance as a stowaway by secreting itself in merchandise, and become established in greenhouses. Walden says that it has been very abundant for several years at Cromwell, Ct., and it was common for some time in a conservatory at Wellesley, Mass., a number of years ago (see remarks under *Periplaneta australasiae*). Scudder records it from Springfield, Mass.

Adventive Species.

Parcoblatta lata (Brunner).

Ischnoptera lata Brunner, Nouv. Syst. Blatt., p. 135 (1865).

A single example of this North American species, identified by Hebard and believed by him to be adventive because so far out of the natural range of the species, is known from New England. The specimen is a female and was captured alive in a dwelling-house at Wellesley, Mass., July 13, 1916. Satisfactory explanation of its presence here is unknown. The species resembles *P. pensylvanica* and its range extends from Delaware and Florida to Missouri and Texas.

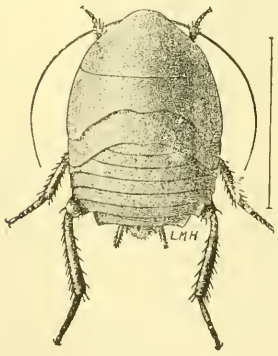


Fig. 42.—Nymph of *Nyctibora* sp. A common tropical Roach introduced on fruit. (After Lugger.)

Exotic species of Roaches from the West Indies, Central or South America are frequently captured in fruit-stores or places where bananas or tropical plants are received, or on the steamers which bring them into port. These are to be regarded as purely accidental specimens, simply waifs and strays, but they are often sent to the entomologist with requests for information. The

Key to Species covers only a few of them. Among them are several very large, broad, and flat-bodied Roaches, either adults with abbreviated tegmina, or young without any, belonging to the genera *Nyctibora* (Fig. 42) and *Eurycotis*. A few specimens have been already recorded but the identification was in some cases incorrect.

Nyctibora laevigata Burmeister (*"sericea"*).

Orono, Me., May 16, 1889, bananas (Me. Exp. Sta.); Manchester, N. H. (Miss Susy C. Fogg); Natick, Mass., summer, 1901, fruit store (2); Wellesley, Mass., fall, 1899, bananas,—nymph, recorded by Scudder (Psyche, vol. 9, p. 100, 1900) as *"Eurycotis*, possibly *finschiana* (Sauss.)."

Nyctibora noctivaga Rehn (*"holosericea"*).

Wellesley, Mass., Jan. 15, 1904, bananas, adult. Young, in various stages, as follows: Hyde Park, Mass., Oct. 1, in house (Miss M. E. Cherrington); Framingham, Mass., May 25, in store (C. A. Frost); Newtonville, Mass., June 12, 1916, (Miss A. W. Wilcox).

Eurycotis opaca (Brunner).

Orono, Me., June 18, 1909, ♀ (Me. Exp. Sta.).

Eurycotis tibialis (Hebard).

Orono, Me., ? adult ♀ (Me. Exp. Sta.).

Epilampra maya (Rehn).

Woodstock, Vt., Aug., 1911 (Hugh Morgan); Framingham, Mass., April 10, 1914, bananas, in grocery store (C. A. Frost).

This is a medium-sized Roach about an inch and a quarter in length, pale buffy brown in color, thickly sprinkled with very fine dusky dots, with a few larger ones scattered over the tegmina and sometimes massed along the basal half of the radial vein to form an irregular dusky streak. The hind margin of the pronotum is strongly produced, with excavate sides and rounded apex.

Green Roaches, about an inch long, are frequently seen and captured, under conditions indicating that they have been accidentally introduced. These are beautiful insects when living,

of a delicate pale green, with semi-transparent wing-covers, and a pale yellow line running backward from the eye through the sides of the pronotum, half the length of the tegmina. These belong to the genus *Panchlora* and have been referred to several species: *viridis*, *nivea*, *hyalina*, *poeyi*, etc. Two species are here represented, according to Hebard, as follows:

Panchlora cubensis (Saussure).

Augusta, Me., 1906, ♀ (U. S. N. M.); Orono, Me., 1892, in tropical fruit (Me. Agr. Exp. Sta.); Woodstock, Vt. (A. P. M.); Boston, Mass., Dec. 26, 1878, flying in store, ♀ (M. C. Z.); Melrose, Mass., June 17, 1914 (F. W. Dodge); Salem, Mass., Aug. 12, 1917; Stoneham, Mass., Nov. 15, 1915 (C. V. Blackburn); Wellesley, Mass., Dec. 12, 1894, on window; Jan. 9, 1918, bananas (A. P. M.).

Panchlora exoleta (Burmeister).

Salem, Mass., June 7, 1884, ♀ , probably in bananas (Peabody Museum, now in Mus. Comp. Zoöl.).

Hormetica advena (Scudder).

Under this name Scudder described a single female Roach taken at Belmont, Mass., in December. This was undoubtedly an adventive specimen of a tropical species, probably introduced with fruit. The species has never been reported since and its native country is unknown.

WALKING-STICKS—Family PHASMIDAE.

In this family the body is very elongate, slender, and cylindrical; the head is exserted; the prothorax is very short, the mesothorax and metathorax elongate; the legs are slender and alike in form. Tegmina and wings are lacking in all United States species.

This family contains some of the most singular insects known, but is represented in New England by only two species, and these are relatively rare as compared with other Orthoptera. A variety of common names has been applied to the Phasmidae, due to their fantastic appearance, but "Walking-stick" is particularly apt and expressive, owing to their striking resemblance in form and color to twigs of shrubs or trees. Protected effectively by this resemblance, they usually move slowly and remain motionless for long periods of time; some species have also a positive means of defence in the ability to eject an offensive spray or slime from special glands. Even the eggs simulate vegetal growths, closely resembling seeds.

Another peculiarity of Walking-sticks is that the legs, if lost, may, under certain circumstances, be regenerated; and individuals exhibiting members in this process are not infrequently seen.

Walking-sticks are purely herbivorous insects and are usually found on shrubs and trees or among grasses; yet a Brazilian species is reported to be aquatic, living in mountain streams, and taking refuge beneath stones when pursued. Though strictly vegetarian in diet, they only rarely multiply, even locally, to such an extent as to become seriously injurious to vegetation.

Two papers by Caudell will prove of especial interest to students of the United States species of this family: *viz.*, "The Phasmidae, or Walking sticks, of the United States," Proc. U. S. Nat. Mus., vol. 26, p. 863–885, 4 plates (1903); and "Notes on Nearctic Orthopterous Insects. I. Non-saltatorial forms, "*ibid.*, vol. 44, p. 595–614 (1913).

Key to New England Walking-sticks.

(See Plate 13.)

A. Cerci from above forceps-like, curving inward (Pl. 13, fig. 22). Operculum (a spoon-shaped organ) beneath eighth abdominal segment.....Males.

B. Hind femora with a prominent, sub-apical, ventro-posterior spine. Cerci with basal internal tooth low, rounded. Eighth abdominal dorsum but half as long as seventh, which is longer than the ninth (Pl. 13, fig. 22) Northern Walking-stick *Diapheromera femorata*, p. 322.

BB. Hind femora without prominent sub-apical spine beneath. Cerci with basal internal tooth slender, sub-cylindrical, blunt at tip. Eighth abdominal segment two-thirds as long as seventh, which is equalled by the ninth....Blatchley's Walking-stick, *Manomera blatchleyi*, p. 326.

AA. Cerci in dorsal view straight (Pl. 13, figs. 16, 20). Valves of ovipositor (two pairs of styliform processes) projecting backward from ventral side of seventh and eighth segments.....Females.

C. Cerci short, less than half as long as ninth dorsum, bluntly tipped. Seventh segment equal to or a little longer than the ninth, about twice as long as the eighth (Pl. 13, figs. 20, 21). Lower pair of valves of ovipositor about reaching end of ninth segment (Pl. 13, fig. 21). Northern Walking-stick, *Diapheromera femorata*, p. 322.

CC. Cerci long and acutely pointed, two-thirds or more as long as the ninth segment. Eighth segment nearly as long as the seventh; ninth longest of the three (Pl. 13, figs. 16, 17). Valves of the ovipositor short, extending only one-third the length of the ninth segment (Pl. 13, fig. 17). Blatchley's Walking-stick, *Manomera blatchleyi*, p. 326.

Northern Walking-stick; Thick-thighed Walking-stick.

Diapheromera femorata (Say).

Fig. 43; Plate 13, fig. 19–22.

Spectrum femoratum Say, Journ. Acad. Nat. Sci. Phila., ser. 1, vol. 4, p. 297 (1825).

Diapheromera femorata Harris, Treatise, 3d ed., p. 146, fig. 67, ♂ (1862) (referred to *Bacunculus* by Uhler in footnote).—Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 379 (1874).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 378 (1873).—Fernald, Orth. N. E., p. 133 (p. 49 of sep.) (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 62, pl. 7, fig. 7, ♀ (1911).

Body cylindrical, extremely long and slender. Antennae one-half to two-thirds as long as body, very slender. Legs long and slender, alike in form and size, the middle and hind femora spined beneath near the end, the spines larger in the male, in which, also, the middle femora are enlarged. Cerci one-segmented, of male cylindrical, incurved, bearing a low, blunt, basal inner tooth; of female short, fusiform (Pl. 13, fig. 20–22).

Body of male smooth, shining; of female dull or waxen. Color usually green or brown, sometimes unicolor, sometimes partly

green and partly brown or gray; the middle femora of the male transversely banded with darker.

Measurements.

	Body and cerci	Antenna	Ant. fem.	Mid. fem.	Hind fem.	Cerci
Male.....	62–74	50–60	18 –22	13 –16.5	19.5	2–3
Female.....	72–90	40–47	17.5–21.5	11.5–14.5	15–17	1–1.5 mm.

Probably no native insect when seen for the first time causes so much astonishment in the uninformed mind as this, which is to all appearances a slender stick or twig incomprehensibly endowed with life and movement. It is widely distributed over the eastern half of the country and inhabits all of the warmer parts of New England, yet it is infrequently seen, and then more by accident than as a result of purposeful search. It matures late in August, and may be found throughout September and well into October. New England records are: South Bridgeton, Me. (Me. Exp. Sta.); Manchester, N. H. (Fogg); Sudbury, Vt. (Scudder); Belchertown, Berlin, Springfield, summit of Mt. Wachusett, and many towns in the vicinity of Boston, Mass., and New Haven, Ct. It probably inhabits the whole of the latter State.

It lives by preference in deciduous shrubbery and woodlands, but, being somewhat of a wanderer, is often met with in quite unexpected places. "It moves very slowly and has a habit of remaining motionless and apparently dead for a considerable length of time. On such occasions it usually stretches itself out from a twig, with its front legs and antennae extended, and then can scarcely be distinguished from a prolongation or branch of the twig. Many people who see them thus for the first time and afterward watch them moving slowly away, can scarcely be persuaded that they are not real twigs, gifted in some mysterious manner with life and motion. In feeding, they eat the edges of a leaf, preferably those of an oak or wild cherry, usually straddling it with their legs, and in an hour will devour a piece an inch long by a third of an inch wide " (Blatchley).

Dr. Riley recorded an outbreak in Yates County, New York, in 1878, in a woodland of fifty acres, which had been attacked two and four years previously. A portion of his account follows: "By the middle of August the bulk of the pests were going through

their last molt, and by the end of autumn they had stripped most of the trees, showing, however, a decided preference for the black, red, and rock-chestnut oaks, over the white oaks and hickories, which they affect but little until after the first-mentioned trees are stripped. The underbrush was also very effectually cleaned of its foliage, and the insects hung from and clung to the bare twigs and branches in great clusters. They settle to roost on the witch-hazel, but do not defoliate it until the other trees mentioned are pretty bare. Sumac and thorn are also little affected, while peach and apple in an adjoining orchard were untouched. Whenever they have entirely stripped the trees and shrubs they move in bodies to fresh pastures, crowding upon one another and covering the ground, the fence rails, and everything about them so that it is impossible for a person to enter the woods without being covered by them. The timber affected can be recognized by its seared and leafless appearance from a great distance, and upon entering the woods the ear is greeted by a peculiar seething noise, resulting from the motion of the innumerable jaws at work on the leaves."

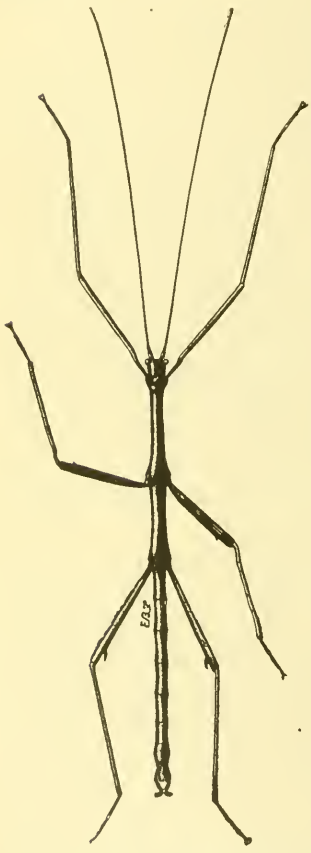


Fig. 43.—Northern Walking-stick, *Diapheromera femorata*. Natural size. (After Lugger.)

A more recent outbreak is reported from Iowa in the summer of 1913 (Journ. Econ. Ent., vol. 7, p. 299, 1914) by Miss Butler, in part as follows: "The woods are principally oak, with smaller numbers of elm, ash, aspen, linden, hickory and black walnut trees and a heavy undergrowth of hazel. On the 30th of May it was observed that the hazel bushes were quite covered with recently hatched walking-sticks, varying from

three or four millimetres to a centimetre in length, in color they were a very palè yellowish green.

"By the first of August they had begun to leave the timber and appear in the orchard and around the house. In the orchard they infested particularly one tree of early apples, devouring nearly all the leaves; on a single twig six inches in length I counted sixteen clustered together and they were equally numerous over the entire tree.

"The woods had become forbidden ground to us; if one were sufficiently brave to start through them, the walking-sticks fell to the ground from every tree in such numbers as to sound like hail. . . . By mid-September the timber showed stretches a couple of hundred feet broad and half a mile long where the trees had been completely defoliated. The walking-sticks began to cross the road to another piece of timber in which there had been almost none of the insects and every passing carriage or motor crushed them by hundreds. This extremely local character of the infestation was a curious feature. One piece of timber containing about 200 acres was almost wholly stripped, while a similar piece across the road was scarcely touched."

The female Walking-stick lays about one hundred eggs, which are singularly seed-like in appearance, veritable tiny beans in aspect, long oval and more or less flattened in shape, black, with a whitish line on the side. "They are simply dropped loosely upon the ground from whatever height the female may happen to be, and, during the latter part of autumn where the insects are common, one hears a constant pattering, not unlike drops of rain, which results from the abundant dropping of these eggs, which in places lie so thick among and under the dead leaves that they may be scraped up in great quantities. . . . The eggs remain upon the ground all through the winter and hatch for the most part during the month of May. Some of them, however, continue hatching much later, so that all through the summer and even into the fall, young individuals may be found. The insect changes very little in appearance from birth to maturity except so far as color is concerned, and molts but twice. With age the green color gives way to various shades of gray and brown" (Riley).

The Northern Walking-stick is said to be abundant in any given locality only every other year. This is due in part, it is believed,

to the fact that a large proportion of the eggs lie on the ground through two winters before hatching.

Outbreaks could doubtless be checked by spraying with arsenical poisons the foliage of the woodlands attacked, or by burning the leaves lying on the ground and thus destroying the eggs.

Blatchley's Walking-stick.

Manomera blatchleyi (Caudell).

Plate 13, fig. 16–18.

Bacunculus blatchleyi Caudell, Journ. N. Y. Ent. Soc., vol. 13, p. 212 (1905).

This is a slenderer and smaller species than *D. femorata*, with the head distinctly longer than wide, and may be readily recognized by the characters stated in the Key. Even the egg may be distinguished at once by the concentric elliptic pattern of the micropylar end (Pl. 13, fig. 18), which in *D. femorata* bears numerous punctures of irregular form and position (Pl. 13, fig. 19). It is brown or green in color, the male paler beneath and showing a dusky lateral stripe on the side of the head and pronotum.

Measurements.

	Total length	Cerci	Antenna	Ant. fem.	Mid. fem.	Hind fem.
Male.....	62	2.5	48		13	17.5
Female.....	74	3.7	40–43	16	14	18 mm.

This is a very rare species in New England. The only record is that of an adult female in my collection which I caught at Greenwich, Ct., August 25, 1892, and which laid eggs after capture. Another, an immature specimen of the same sex, without data, I think was taken at the same place and time. Originally described from Indiana, this species will probably be found at many intermediate points after further search.

PRAYING MANTES, SOOTHSAYERS, etc.—Family MANTIDAE.

In this family the body is elongate, the head free, transverse, the face vertical; the front legs are raptorial, the coxae free, elongate, the femora and tibiae enlarged and spined for seizing insect prey; the middle and hind legs are slender.

The Mantidae differ from all other Orthoptera in being exclusively carnivorous, capturing and feeding upon living insects; in consequence, they are esteemed as highly useful and beneficial creatures.

While they can run rapidly and do so when alarmed, their customary movements when in the presence of their prey are very deliberate; stealing along until within striking distance, the fore leg is suddenly extended to seize the victim which is impaled upon the sharp spines of the thigh and shank, carried to the mouth, and eaten while still struggling to escape. The females are cannibalistic, and are prone to devour their mates after their usefulness as such is over, a habit which is paralleled among spiders.

The eggs are laid in a bulky mass (oöthéca) attached to twigs of trees or stems of grasses. The masses have a braided appearance externally, due to the arrangement of the mucous covering at the time of oviposition which hardens into a tough protective envelope on exposure to the air. The winter is spent in the egg stage, the young hatch in spring, and when they emerge, seek plant lice and other soft-bodied insects for their first food.

The young Mantis on hatching is said to hang suspended by a pair of silken threads attached to the cerci until after its first molt, and to differ remarkably in proportions from the adult, the peculiar fore legs not yet having assumed their characteristic form.

This family of insects is apparently not naturally present in New England. One native species has been recorded from Rhode Island (see *Stagmomantis carolina*) but its occurrence there is probably to be regarded as accidental. Several attempts have been made to introduce two foreign species, acclimated in other parts of the country, but did not meet with entire success. It is to be hoped that efforts to introduce these beneficial Orthoptera

will be persevered in until successful or until it is definitely shown that our climate is unsuited to them.

For further information the student is referred to the following works:

Sharp,—Cambridge Natural History, vol. 5, chap. 10 (1895).

Caudell,—"Notes on Nearctic Orthopterous Insects," Proc. U. S. Nat. Mus., vol. 44, p. 605–608 (1913).

Rau and Rau,—"The biology of *Stagmomantis carolina*," Trans. Acad. Sci. St. Louis, vol. 22, no. 1, p. 1–56, pl. 1–18 (1913).

Key to Species of Mantidae recorded from New England.

A. Very large; both sexes about 90 mm. (3½ inches) long; hind femora about an inch (26 to 27 mm.) long.
Chinese Mantis, *Paratenodera sinensis*, p. 329.

AA. Size medium, (2 to 2¾ inches long, hind femora 15 to 18 mm.)

B. Facial shield (between eyes, below antennae) nearly (♀) or quite (♂) three times as wide as median length.
Carolina Mantis, *Stagmomantis carolina*, p. 328.

BB. Facial shield about twice as wide as long.
European Mantis, *Mantis religiosa*, p. 330.

Carolina Mantis.

Stagmomantis carolina (Johannsen).

Gryllus carolinus Johannsen, Amoen. Acad., vol. 6, p. 396, n. 28 (1763).
Stagmomantis carolina Scudder, Psyche, vol. 9, p. 119 (1900), (reported by Henshaw).

Color: Male, grayish brown. Tegmina semi-transparent, grayish, more or less mottled with dark smoky brown; sometimes almost wholly brown. Body and feet often yellowish green. Middle and hind knees, and front coxae and femora banded with dark brown in the brown form. Female: either similar in color to the male, or wholly green, the tegmina opaque; a yellow-bordered blackish spot on the tegmina, more distinct in the green form.

Measurements.

	Body	Pronotum	Tegmina	Ant. fem.	Ant. tib.	Post. fem.	Antenna
Male ...	49–57	16 –18	32–37	9.5–11.5	7	13–14	24
Female..	52–62	18.5–22	23–24.5	13–16	10	15–19	13–15 mm.

This species was reported by Mr. Samuel Henshaw to Mr. Scudder as having been taken in Rhode Island. Mr. Henshaw

informs me that Professor A. S. Packard stated at the time of capture that the evidence seemed to indicate that the specimen was a native of the State. No additional occurrences having been reported since that time either in Rhode Island or in other New England localities it seems best to regard the single capture as that of an adventive specimen, accidentally or intentionally introduced. The species is rarely met with even in southern New Jersey and is normally restricted to a much warmer climate than characterizes even the southern part of New England.

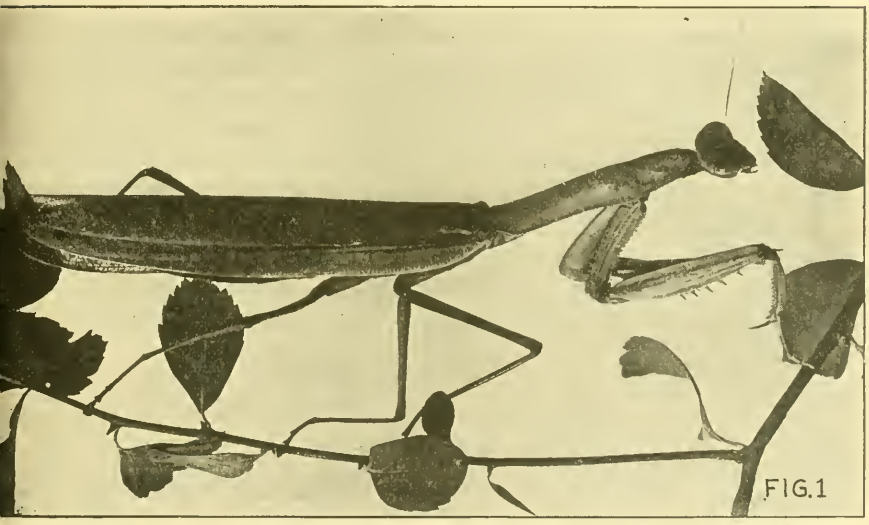


Fig. 44.—Chinese Mantis, *Paratenodera sinensis*. (After Walden.)

Chinese Mantis.

Paratenodera sinensis (Saussure).

Fig. 44.

Tenodera aridifolia var. *sinensis* Saussure, Mém. Soc. Génève, vol. 21, p. 295, pl. 7, fig. 62 (1871).

Tenodera sinensis Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 60 (1911).

Green; the dorsal field of the closed tegmina in the male more or less brown.

Measurements.

	Body	Tegmina	Pronotum	Ant. fem.	Ant. tib.	Post. fem.	Antenna
Male.....	89	61	25	19	12	26	42
Female....	89	58	26	21	13	27	15 mm.

This Mantis became established in the neighborhood of Philadelphia in the late '90's in the vicinity of large nurseries which imported plants from the Old World. Egg-masses from this colony have been distributed from time to time in the hope of promoting the widespread introduction in this country of this beautiful and useful insect. A few were placed out at Wellesley and a single adult was captured in the fall of the same season. Better luck attended their introduction into Connecticut, where Walden states that twenty-five masses were placed in five localities in the winter of 1904 with the result that about a dozen adults were seen in three of these localities the following autumn and a few were found the second season, showing that the insect may live through the winter in southern New England. It has also apparently been introduced a second time into Connecticut on plants received directly from Japan. It is, however, very doubtful whether it has become permanently established within our limits.

European Praying Mantis.

Mantis religiosa (Linné).

Gryllus (*Mantis*) *religiosa* Linné, Syst. Nat., ed. 10, vol. 1, p. 426 (1758).
Mantis religiosa Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 60 (1911).

Nearly uniform green or pale brown, with an oval dark spot on the inner face of the front coxae near the base.

Measurements.

	Body	Tegmina	Posterior femora
Male.....	40–53	29–36	14–16
Female.....	48–76	32–49	15–18 mm.

This well-known European insect has become established in the vicinity of Rochester, New York. The original introduction was probably accidental, with nursery stock. "As this species often lays its egg-masses on the stems of grass it has been suggested that an egg-mass might have been in the hay which is often

used for packing when shipping nursery stock. Egg-masses of this species were obtained in 1903 and brought to Connecticut but they failed to hatch" (Walden). "I introduced the European Mantis here [Amherst, Mass.] some years ago and carried specimens through, in the field, to practical maturity, but they did not reappear the following year" (H. T. Fernald).

The Saltatorial Orthoptera.

The Saltatoria or jumping Orthoptera, like the Non-Saltatoria, comprise three families: the true, or long-horned Grasshoppers, including also the Katydids and Cave-crickets; the true Crickets, including Field-, Tree-, and Mole-crickets; and the Locusts, which are, however, more commonly known as "grasshoppers" than even the Grasshoppers themselves. The relationship of these various groups has received attention elsewhere and need not be considered here. They are all characterized by the presence of elongate hind legs and stout thighs, a specialization which enables them to leap with suddenness and effect, and which is undoubtedly of great assistance in eluding their enemies. The only exception, and that but partial, is the Mole-cricket, in which an even greater specialization of the front legs for burrowing is correlated with a reduction in size of the hind legs to such an extent as nearly to unfit them for leaping.

The Saltatorial Orthoptera are, beyond question, the musicians of the insect world, a position, it is true, which they share with the cicadas, whose music, however, is less pleasing to human ears. All three families contain numerous members which make stirring appeals to human interest through the ear, the performances varying widely in method, in form, in timbre, and in the circumstances of delivery. Without the efforts of these little creatures the summer days and autumn nights would lose much of the charm of sound associated even unconsciously with those seasons.

KATYDIDS, GREEN OR LONG-HORNED GRASSHOPPERS, SHIELD-BACKED GRASSHOPPERS, AND CAVE-CRICKETS—Family TETTIGONIIDAE.

The members of this family, known more generally hitherto as Locustidae or Locustarians, are characterized by the possession of extremely long, finely tapering antennae, four-jointed tarsi without pads between the claws, a compressed, blade-like ovipositor, organs of hearing situated on the front tibiae, and wing-covers with the larger part of their surface sloping at the side of the body. The wing-covers of the male are modified to form a sounding-board for the stridulating apparatus. This is located near the base of the wing-cover and consists of a transverse ridge bearing a series of teeth which act upon a stiffened edge on the other wing-cover, causing both to vibrate and produce a scraping sound.

Their stridulatory powers have placed them in the front rank of insect musicians, on a plane with the Crickets; and their performances have long attracted attention, that of our arboreal "Katydid" being especially noteworthy. These habits are treated more at length under the headings of the various species.

Their coloring parallels that of the Crickets: those species which live on the ground, hiding themselves among fallen leaves, beneath stones, and in holes, present the dull tints of their surroundings; while those living among the verdure of the fields, in grass and herbage generally, in the green leafage of bushes and trees, are with few exceptions of a similar grass- or leaf-green hue. These vary specifically in tint, with more of yellowish or bluish, in some instances exhibiting also a distinct pale-brown phase, and very rarely a striking pink variation.

Protected by their color and in some cases by very retiring habits, many more kinds live about us than we realize. While some are as active both in movement and in song by day as by night, others are exclusively nocturnal, revealing themselves to our eyes and ears only after the glare and noise of daylight have ceased.

They are mainly herbivorous in diet, but animal substances do not come amiss to them and are devoured greedily by some species. Though the aggregate amount of vegetation consumed by these insects is unquestionably very great, their depredations pass

unnoticed save in a few instances because their attacks are confined almost entirely to uncultivated plants or those of little commercial value. An exception exists in the case of cranberries, considerable quantities of which are sometimes destroyed by Bush-katydids (*Scudderia*) in the process of getting at the seeds, of which they are very fond.

Their life history is typical for the majority of the order: the winter is passed in the egg stage, hatching takes place in the spring, growth is rapid, maturity is reached in midsummer, and oviposition in early autumn closes the cycle. Probably in certain cases (*e.g.*, Cave-crickets) some individuals live over winter.

The egg-laying habits are of special interest. In most instances the eggs are laid on or within vegetable tissue, but the exact method varies with the species, ranging from simple attachment to the surface of a leaf or twig by a sticky secretion, to the saw-like slitting of the leaves of the oak, or the thrusting of a long ovipositor down between the stem and leaf-sheath of grasses or among the scales of the pine-cone willow-gall, and the emplacement of the eggs in the security thus afforded.

The characters most useful in discriminating the genera and species are those drawn from the form of the vertex of the head, pronotum, and prosternum, the form and venation of the tegmina, the armature of the legs, and the genitalia, the relative value of the different parts varying much in different groups.

Fortunately for the student of the New England species of this family the various genera (with the exception of the Ceuthophili) have been critically studied recently and an excellent series of articles published thereon, illustrated with plates of diagnostic details of structure. A list of them is given below. For information concerning their songs see the list of papers under Stridulation.

Amblycorypha Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 40, p. 271–314, pls. (1914).—Hancock, Ent. News, vol. 27, p. 70–82 (1916). (Pink katydids.)

Atlanticus Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 42, p. 33–100, 3 pls. (1916).

Ceuthophilus Scudder, Proc. Amer. Acad. Arts and Sci., vol. 30, p. 17–113 (1894).—Walker, E. M., Can. Ent., vols. 36, 37 (1905, 1906), pl. (*Ceuthophilus* spp.—one drawing incorrect).—Caudell, Proc. U. S. Nat. Mus., vol. 49, p. 655–690, figs. (1916); *Diestrammena* also.

Conocephalus Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 41, p. 155–224, pls. (1915).

Diestrammena. See *Ceuthophilus.*

Neoconocephalus Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 40, p. 365–413, pls. (1914).

Orchelimum Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 41, p. 11–83, pls. (1915).

Pterophylla Caudell, Journ. N. Y. Ent. Soc., vol. 14, p. 32–48, pl. (1906).

Scudderia Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 40, p. 315–344, pls. (1914).

Key to Subfamilies and Genera of Tettigoniidae.

A. Tegmina and wings, or their rudiments, present; stridulatory and auditory organs present.

B. Prosternum without a pair of sharp, erect spines.

Subfamily Phaneropterinae.

C. Tegmina and wings fully developed, much exceeding body; wings passing tegmina.

D. Vertex of head very broad anteriorly, smoothly rounded.

Round-headed Katydids, *Amblycorypha* spp., p. 336.

DD. Vertex of head narrowed anteriorly to a compressed tubercle, grooved above and not as wide as first antennal joint.

Bush-katydids, *Scudderia* spp., p. 339.

CC. Tegmina rudimentary, little longer than pronotum; wings abortive.

European Bush-katydid, *Leptophyes punctatissima,* p. 348.

BB. Prosternum armed beneath with a pair of sharp, erect spines.

E. Pronotum of normal size. Color green (sometimes very pale brown). Tegmina and wings usually fully developed,—in two species reduced.

F. Tegmina very broad, with leaf-like veins, concave, enclosing the body and wings. . . . . Subfamily Pseudophyllinae.

True Katydid, *Pterophylla camellifolia,* p. 350.

FF. Tegmina narrow, expanding but little in the middle.

Subfamily Conocephalinae.

G. Head conical; vertex broad, usually much prolonged in advance of eyes. Large insects with greatly elongated tegmina.

Cone-heads, *Neoconocephalus* spp., p. 353.

GG. Vertex narrow, projecting but little, strongly hollowed out laterally for reception of basal antennal joints.

H. Robust species; ovipositor stout, upcurved.

Large Meadow- or Green-grasshoppers, *Orchelimum* spp., p. 359.

HH. Slender species; ovipositor slender, straight or but little upcurved.

Smaller Meadow-grasshoppers, *Conocephalus* spp., p. 363.

EE. Pronotum very large, extending backward behind the lower part of the lateral lobes a distance at least equal to that in front. Tegmina rudimentary; wings abortive. Color brown.

Shield-backed Grasshoppers, Subfamily Decticinae, p. 370.

AA. Entirely apterous, without even rudiments of tegmina and wings. Stridulatory and auditory organs apparently absent.
Cave-crickets, Subfamily STENOPELMATINAE, p. 373.

THE ROUND-HEADED KATYDIDS—AMBLYCORYPHA.

New England is inhabited by three species of large, Round-headed Katydids belonging to the genus *Amblycorypha*. Two species probably occur throughout the Transition area as far north as southern Maine, New Hampshire, and Vermont; the other has as yet been found only in southern Massachusetts, but probably occurs in coastwise Connecticut also.

The head is round and full; the vertex broad, smooth, convex, without groove or projections; eyes of moderate size, elliptic; pronotum flat above and more or less narrowed anteriorly, abruptly bent downward at the sides, its front margin straight or a little concave, hind margin convex; lateral lobes varying from a little deeper than long to the reverse, their front margin concave, hind margin strongly convex, the humeral sinus rectangular or obtuse-angled. The legs are long and slender; the hind femora weak, with from 1 to 5 short spines beneath, and equalled or slightly exceeded by the hind tibiae. The tegmina equal or pass the hind knees by 4 to 6 mm., and are surpassed as much by the wings, with dorsal area small and horizontal, lateral area flat, nearly vertical. Subgenital plate of male V-emarginate; cerci not reaching its hind margin, rather stout, gently incurved, tapering to an acute, spur-like tip. Ovipositor large, broad, curved upward scimitar-like, the distal half of its dorsal edge and third of the ventral edge set with numerous prominent, nearly erect and symmetrical, and rather widely placed teeth.

In color these Katydids are usually a dull pea-green, very pale or nearly white beneath, with the dorsal area of the male tegmina purplish brown. In drying, specimens are particularly apt to discolor, becoming yellowish brown, unless stuffed or treated with formaldehyde. Rarely, examples are found of a bright rose-pink color, a phenomenon concerning which various theories have been advanced but which has not yet been satisfactorily explained (for bibliographical references to this subject and to experiments see Ent. News, vol. 27, Feb. 1916).

Key to New England Species of Amblycorypha.

A. Tegmina $3\frac{1}{4}$ to $3\frac{1}{2}$ times as long as broad.

B. Size large; tegmina 34 x 9.5 to 39 x 12 mm.; hind femora 28 to 30 mm. Tegmina pass hind knees 4 to 8 mm.; wings pass tegmina 6 to 8 mm. Pronotum strongly narrowed (one-third) anteriorly; humeral sinus deep, rectangular; lateral lobes deeper than long.

Oblong-winged Katydid, *A. oblongifolia*, p. 337.

BB. Size medium; tegmina about 32 x 9 to 36 x 11 mm.; hind femora 27 to 30 mm. Tegmina pass hind knees 2 to 5 mm.; wings pass tegmina 3 to 5 mm. Pronotum less narrowed anteriorly, humeral sinus less deep, lateral lobes as deep as long.

Carinate Florida Katydid, *A. floridana carinata*, p. 338.

AA. Tegmina $2\frac{1}{2}$ to $2\frac{3}{4}$ times as long as broad; size small. Tegmina short and broad, 23 x 8.5 to 25 x 10 mm.; hind femora 21.5 to 26 mm. Tegmina about reaching hind knees; wings pass tegmina 3 to 5 mm. Pronotum but little narrowed anteriorly, lateral lobes longer than deep, humeral sinus obtusely excised....Round-winged Katydid, *A. rotundifolia*, p. 338.

Oblong-winged Katydid.

Amblycorypha oblongifolia (DeGeer).

Fig. 45; Plate 14, fig. 1.

Locusta oblongifolia DeGeer, Mém. Hist. Ins., vol. 3, p. 445, pl. 38, fig. 2 (1773).

Phylloptera oblongifolia Scudder, Boston Journ. Nat. Hist., vol. 7, p. 444 (1862).—Harris, Treatise, 3d ed., p. 159, text (not fig.) (1862).

Amblycorypha oblongifolia Smith, Rept. Ct. Bd. Agric. for 1872, p. 357 (1873). —Fernald, Orth. N. E., p. 105 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 130 (1911).

With the exception of the true Katydid this is our largest species. It frequents shrubbery and small trees, preferably in moist places, crawling slowly about and sometimes flying leisurely from place to place, when its large tegmina and wings make it a conspicuous object. It reaches maturity by mid-August in New England (June in Louisiana) and probably can be found throughout Sep-

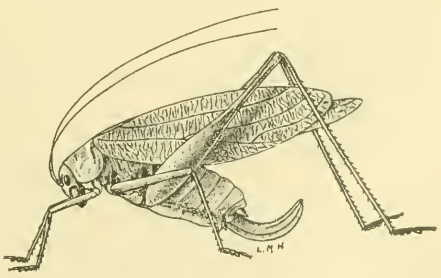


Fig. 45.—Oblong-winged Katydid, *Amblycorypha oblongifolia*. (After Lugger.)

tember and early October. It is much less common near Boston than its round-winged relative, but is recorded from Seabrook, N. H., several points near Boston, Connecticut, Montreal, southward to New Orleans, and westward to Colorado and Texas.

According to Allard, its stridulation "consists of a single brief phrase repeated at more or less regular intervals. When heard close by, it is apparent that this note begins with a very rapid crepitation, which may be likened to the sudden rasping of an object across the teeth of a comb. This terminates sharply with a sound remotely like '*itzic.*' The entire song may be likened to the syllables, *z-z-z-z-itzic.*"

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna	Ovipositor
Male.....	51	21–25	37–38 x 10–12	28–30	45	
Female.....	46	27	34 x 9.5	26	38	12 mm.

Carinate Florida Katydid.

Amblycorypha floridana carinata Rehn and Hebard.

Amblycorypha floridana carinata Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 40, p. 323 (1914).

Measurements (from southern examples).

	Total	Body	Tegmina	Hind femora	Antenna	Ovipositor
Male.....	43–48	19–24	32–37.5	29 –31.8	42	
Female.....		22–27	30–35.5	26.7–32.6	37	12.3–14.5 mm.

This is a medium-sized member of the genus with tegmina and wings proportionally shorter than in the Oblong-winged Katydid. Half a dozen examples are recorded by Rehn and Hebard from Nantucket and Woods Hole, Mass., and it will probably be found in southern Connecticut. Extralimitally it extends to Georgia, and another subspecies, from which this is distinguished by having more pronounced lateral angles on the disk of the pronotum, to Florida and Texas.

Round-winged Katydid.

Amblycorypha rotundifolia (Scudder).

Plate 14, fig. 2.

Phylloptera rotundifolia Scudder, Boston Journ. Nat. Hist., vol. 7, p. 445 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 357 (1873).—

Fernald, Orth. N. E., p. 105 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 130 (1911).
Phylloptera oblongifolia Harris, Treatise, 3d ed., fig. 75, ♀ (1862).

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna	Ovipositor
Male.....	33–37	18	23.7–27	21.8–25.5	35	
Female.....	33–37	16–25	23.7–27	23.5–26	35	8.8–10.8 mm.

The Round-winged Katydid is our smallest and most common species of the genus. It is frequently captured by sweeping the net over low-growing shrubs and dense grass in moist fields near shrubbery. It matures in late July or in August and may be found throughout September. It is recorded from eastern Massachusetts, Connecticut, southern Vermont, and extends, in three closely related races, to North Carolina, Texas, and Iowa.

Scudder remarks that "it stridulates both by day and by night and without variation. The song consists of from two to four syllables . . . sounding like *chic-a-chee*, repeated rapidly so as to be almost confounded, and when three requiring just one-third of a second. The song is repeated at will, generally about once in five seconds, for an indefinite length of time."

THE BUSH-KATYDIDS; NARROW-WINGED KATYDIDS—SCUDDERIA.

New England is the home of several species of Katydid-like insects distinguished by the possession of certain peculiar characters which unite them into a single genus, named in honor of our most prominent resident student of the Orthoptera, *Scudderia*.

They are large yellowish-green insects with strongly compressed body, vertical wing-covers, and slender antennae of moderate length. In sharp contrast to the Round-headed Katydids, the vertex of the head in these insects is strongly narrowed between the antennae and acuminate at apex. The females have a short, broad, strongly compressed and upcurved ovipositor, and resemble each other closely. The form of the terminal segments of the male abdomen is peculiar and characteristic of each species: in general, the subgenital plate is greatly extended into a long, upcurved process, broad and depressed at base, narrow and

depressed or somewhat compressed apically, grooved above, often shallowly cleft at tip; the last dorsal segment of the abdomen (anal segment, supra-anal plate) is likewise, in most species, extended into an elongate, median process of complicated structure, often more or less forked at apex, which meets or embraces at its tip the upcurved subgenital plate.

From their habitat in tall grasses, low shrubs and bushes in general, I have ventured to christen them Bush-katydids, in contrast to the true or arboreal Katydid whose home is among the branches of tall trees. Several species are sufficiently numerous to be often seen and frequently heard during the latter part of summer and early autumn, though their stridulation is not so loud as to force itself on the attention, as does that of the true Katydid. Five species and a closely related race or subspecies are known from our territory, only one of which is rare.

The young are quaint little creatures with enormously long antennae, green above, daintily varied with fine dusky and reddish spots, white beneath, and move very slowly. They are common, and may be readily found in the haunts of the adults, clambering deliberately about with gently waving antennae and solemn, staring eyes.

Key to the Species of Scudderia.

MALES.[1]

A. Last dorsal segment of abdomen not produced into an elongate median process. Subgenital plate not compressed apically. Cerci long, gently incurved.....Northern Bush-katydid, *S. septentrionalis*, p. 342.

AA. Last dorsal segment of abdomen bearing an elongate median pistillate process. Subgenital plate more or less compressed apically. Cerci short, bent abruptly inward.

B. Median process truncate at tip with thin, vertical, backward-projecting lateral flanges which enclose the sides of the subgenital process.
Texan Bush-katydid, *S. texensis*, p. 343.

BB. Process bifurcate or emarginate at tip, the forks lobed ventrally in side view.

C. Process deeply bifurcate at tip, the opening between the forks much too narrow to admit the process of the subgenital plate.
Fork-tailed Bush-katydid, *S. furcata*, p. 347.

CC. Process emarginate, or but slightly bifurcate at tip.

[1] Females of this family of insects may be recognized at once by the presence of a compressed, blade-like ovipositor, either straight or up-curved.

D. Tegmina relatively broad, less than four times as long as broad, the apical half wider than the basal half. Hind legs relatively short. Apex of median process of anal segment in side view dull, the subapical ventral vertical flanges continued to the apices of the lateral lobes.....Pistillate Bush-katydid, *S. pistillata*, p. 344.

DD. Tegmina relatively narrow, four to five times as long as broad, the apical half not wider than the basal. Apex of median process of anal segment in side view sharp, acuminate, the subapical ventral vertical flanges not continued to the apices of the lateral lobes.

E. Larger; tegmina and hind legs elongate (teg. 33 to 37, h. fem. 25 to 29 mm.).

Curve-tailed Bush-katydid, *S. curvicauda curvicauda*, p. 345.

EE. Smaller; tegmina and hind legs relatively short (teg. 25 to 29, h. fem. 21 to 23 mm.).

Northern Curve-tailed Bush-katydid, *S. c. borealis*, p. 346.

Females.[1]

(Plate 13, fig. 4–9.)

A. Ovipositor evenly curved throughout, long, more than half as long again as the pronotum.....Northern Bush-katydid, *S. septentrionalis*, p. 342.

AA. Ovipositor short, bent upward more or less abruptly near base.

B. Tegmina relatively broad, less than four times as long as wide, their apical half noticeably wider as a whole than the basal half; disk of pronotum short and broad, distinctly broadened backward.

Pistillate Bush-katydid, *S. pistillata*, p. 344.

BB. Tegmina relatively narrow, four to five times as long as wide.

C. Smaller forms (hind fem. 22, teg. 27 mm.). Disk of pronotum with sides nearly parallel.

D. Ovipositor relatively narrow, three and a half times as long as wide.

Fork-tailed Bush-katydid, *S. furcata*, p. 347.

DD. Ovipositor broader, only two and a half times as long as wide.

Northern Curve-tailed Katydid, *S. curvicauda borealis*, p. 346.

CC. Larger forms (hind fem. 26 to 30, teg. 29 to 36 mm.).

E. Tegmina glossy. Disk of pronotum distinctly broadened posteriorly; anteriorly somewhat convex, the lateral carinae less developed; hind margin of lateral lobes protuberant backward. Ovipositor bent abruptly upward near base, widest at base.

Texan Katydid, *S. texensis*, p. 343.

EE. Tegmina dull. Disk of pronotum broader and flatter anteriorly; hind margin of lateral lobes smoothly rounded. Ovipositor less bent, widest on apical half.

Curve-tailed Bush-katydid, *S. curvicauda curvicauda*, p. 345.

[1] The females of this genus are extremely difficult for the novice to separate. Only careful study of considerable series will render the typical characters appreciable.

Northern Bush-katydid.

Scudderia septentrionalis (Serville).

Figs. 46, 47; Plate 14, figs. 3, 4.

Phaneroptera septentrionalis Serville, Hist. Nat. Ins., Orthopt., p. 416 (1839).

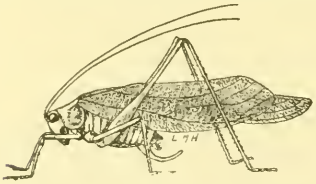
Scudderia septentrionalis Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 129 (1911).

Size small. Tegmina broad throughout, well rounded at apex and on front margin, with dull surface. Last dorsal abdominal segment of male truncate, with obtuse-angulate hind margin. Ovipositor long and regularly arcuate.

Measurements.

	Total Body	Teg. L.	Teg. W.	Wgs. > Teg.	H. fem.	Ant.	Pron.	Ovipositor
Male . .	37	27	7.5	5.5	18.6	37+	4.8	
Female.	20	26.5	7.5		18.5		5	8.75 x 2.5 mm.

This is an exceedingly rare species of which but few examples are known. Both sexes may be recognized at once, the female by the exceptionally long, evenly curved ovipositor, the male



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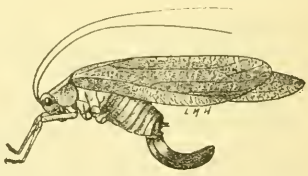

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Fig. 46.—Northern Bush-katydid, *Scudderia septentrionalis*. Male. (After Lugger.)
Fig. 47.—The same; female. (After Lugger.)

by the lack of any elongate process on the anal segment of the abdomen.

It has been found in July and August in Maine, Massachusetts, New Jersey, Wisconsin, and Nebraska. Two specimens are reported as having been captured in woods, or on undergrowth in woods; aside from these instances no data on its habits are known.

Texan Bush-katydid.

Scudderia texensis Saussure and Pictet.

Fig. 48; Plate 14, fig. 8.

Scudderia texensis Saussure and Pictet, Biol. Centr.-Amer., Orth., vol. 1, p. 330 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 126 (1911).

Measurements.

	Total	Teg. L.	Teg. W.	Wgs.>Teg.	H. fem.	Ant.	Pron.	Ovip.
Male . .	44–48	33–38	7.5–8	5.5–6	26–30	40–?	5.5–6	
Female.	43–47	33–38	7.5–8	5.5–6	26–30	35–40	5.5–6	7mm.

This is a common large Bush-katydid, the males of which may be distinguished at once by the concave tip of the anal plate; the females are likely to be confused with those of *S. curvicauda* until after critical study of sufficient material.

Rehn and Hebard state that it "is almost invariably found in or near marsh, swamp, or bog." It is one of the few notably destructive species, damaging cranberries especially, on the bogs of New Jersey, by eating into the berries in order to get the seeds. Rehn and Hebard report it as locally abundant after dark along the salt-marshes of New Jersey, "in areas of Scirpus, resting head down and motionless near the tips of these rushes and frequently beaded with dew. On bright warm afternoons it was observed in the taller vegetation near the border of the salt-marshes, where the males were moving actively about emitting their rather prolonged and harsh stridulation."

Fig. 48.—Texan Bush-katydid, *Scudderia texensis*. End of male abdomen. *a*, side; *b*, dorsal view. (After Scudder.)

The eggs "are laid in the edges of leaves between the upper and lower epidermis, and at first are so thin that they are not noticeable except when the leaf is held between one's self and the light. They are loosely inserted in these pockets made by the ovipositor of the mother, and as they swell in coming in contact with the ruptured tissues of the plant, they are held tightly in place. The winter of this, as well as of the other species of the genus, is passed in the egg stage, the young appearing about the last of April" (Indiana—Blatchley).

In New England it has been taken at Norway, Me.; Seabrook, N. H.; in eastern Massachusetts, Rhode Island, and throughout Connecticut, on various dates from late July till well along into September. Extralimitally it extends to Florida, Texas, and Montana.

Broad-winged Bush-katydid; Pistillate Bush-katydid.

Scudderia pistillata Brunner.

Fig. 49; Plate 14, fig. 5.

Scudderia pistillata Brunner, Monogr. Phaner., p. 240 (1878).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 128 (1911).

Measurements.

	Total	Teg. L.	Teg. W.	Wgs.>Teg.	H. fem.	Ant.	Pron.	Ovip.
Male ..	35–46	26–35	8–10	5–6.5	17–23	25–40	5–6.3	
Female.	33–41	26–32	8–9	3–4	19–22	30–	5–6	7 mm.

Superficially this insect somewhat resembles *S. septentrionalis* and *S. curvicauda borealis*. The form of the tegmina and ovipositor, and the small size of the eyes are useful characters in distinguishing it.

This is a boreal species whose habitat covers New England and extends at least from Halifax, Nova Scotia, to northern New Jersey, and as far west as Wyoming and Saskatchewan. It is apparently the commonest species in northern Maine, judging from the number of specimens in the Maine State Experiment Station, and from my own experience, having taken it at Whitneyville, Houlton, Ft. Fairfield, Orono, Hoxie, and Norway. It is known also from each of the other New England States. Dates of capture range from July 21 to September 4.

Fig. 49.—Broad-winged Bush-katydid, *Scudderia pistillata*. End of male abdomen. *a*, side; *b*, dorsal view. (After Scudder.)

Rehn and Hebard speak of this species as follows: "The present insect, which is found in greatest numbers in the southern portions of the Canadian Zone, is usually met with in clusters of low bushes, such as wild rose, hazel and alder, in the open. Males are least active of any of the species of the genus, taking wing much

less often when disturbed. The females are even more secretive than the males and usually prove very hard to find. We have never seen this sex take wing."

Curve-tailed Bush-katydid; Narrow-winged katydid.

Scudderia curvicauda curvicauda (DeGeer).

Fig. 50; Plate 14, fig. 6.

Locusta curvicauda DeGeer, Mém. Hist. Ins., vol. 3, p. 446 (1773).
Phaneroptera angustifolia Harris, Treatise, 3d ed., p. 161 (1862).
Phaneroptera curvicauda Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 357 (1873).
Scudderia curvicauda Fernald, Orth. N. E., p. 106 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 127 (1911).

Measurements.

	Total	Body	Teg. L.	Teg. W.	Wgs.>Teg.	H. fem.	Ant.	Pron.	Ovip.
Male...	41–49	21–24	32–36	7.5–8	6 –7	23–27	35–40	5.5–6	
Female.	42–48	23–28	32–36	7.5–8	5.5–6	25–29	35–40	5.5–6	7 mm.

This is probably our commonest large Bush-katydid. The female is likely to be confused with that of *S. texensis;* the male may be identified without serious difficulty. This race inhabits all of southern New England, at least as far north as middle Vermont (Brandon), and southwestern Maine (Fryeburg), is found throughout New Jersey, and westward to Wisconsin. In the latitude of Virginia and Oklahoma it intergrades with and passes, southward, into another race, typical only in the extreme south (Florida to Mississippi). Northward, likewise, it probably intergrades with the small northern race or subspecies (*S. c. borealis*) found in the boreal districts of Maine, Ontario, and Manitoba.

Fig. 50.—Curve-tailed Bush-katydid, *Scudderia curvicauda curvicauda.* End of male abdomen. *a*, side; *b*, dorsal view. (After Scudder.)

Adults of this race appear in New England in the latter half of July, are plentiful in August, and probably linger until killed by frost.

Rehn and Hebard record this Bush-katydid as "common and widely distributed through the undergrowth of the Pine Barrens

of New Jersey. . . . The species was heard there in the daytime giving at long intervals a brief note '*zzikk*' much as has been observed in *Sc. pistillata;* at night it was often to be heard giving single or a succession of rather resonant and loud stridulations."

Scudder states that "it is more noisy by night than by day; and the songs differ considerably at these two times. The day song is given only during sunshine, the other by night and in cloudy weather. I first noticed this while watching one of the little creatures close beside me; as a cloud passed over the sun he suddenly changed his note to one with which I was already familiar, but without knowing to what insect it belonged. At the same time all the individuals around me, whose similar day song I had heard, began to respond with the night cry; the cloud passed away, and the original note was resumed on all sides. Judging that they preferred the night song to that of the day, from their increased stridulation during the former period, I imitated the night song during the sunshine, and obtained an immediate response in the same language. The experiment proved that the insects could hear as well as sing. . . . The note by day is *bzrwi* and lasts for one-third of a second. The night song consists of a repetition, ordinarily eight times, of a note which sounds like *tchw*. It is repeated at the rate of five times in three-quarters of a second, making each note half the length of the day note."

Northern Curve-tailed Bush-katydid.

Scudderia curvicauda borealis Rehn and Hebard.

Plate 14, fig. 7.

Scudderia curvicauda borealis Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 40, p. 281 (1914).

Measurements.

	Total	Body	Teg. L.	Teg. W.	Wgs.>Teg.	H. fem.	Pron.	Ant.	Ovip.
Male . .	36–40	17–19	26–29	6.5–7	4.5–5.5	20.5–23	5 –5.5	30+	
Female.	35–37	18–21	25–26	6 –6.5	4 –4.5	21–21.5	5.2–5.5	30+	7 mm.

This is a small boreal race of the common Curve-tailed Bush-katydid and inhabits the northern part of the country from eastern Maine to Manitoba. Continued collecting will probably reveal its presence in much of the Canadian Zone. The half dozen specimens in my collection were captured on cold, heath-

grown bogs at Cherryfield, Orono, and Whitneyville, Me., August 5 to 30, 1913.

Owing to its diminutive size the female is likely to be mistaken, at first glance, for *S. pistillata* or *S. furcata*.

Fork-tailed Bush-katydid.

Scudderia furcata Brunner.

Plate 14, figs. 9, 10.

Scudderia furcata Brunner, Monogr. Phaner., p. 239 (1878).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 128 (1911).

Small; tegmina narrow; front margin of pronotum nearly as wide as hind margin. Notch in end of process of anal plate of male deep, open, with parallel sides, the lobes bounding it large and swollen, forming a widely cleft miniature hoof-like structure.

Normally uniform green in color, occasional individuals present a brownish suffusion or purplish striping,—to one of these Beutenmüller applied the name *fasciata*.

Measurements.

	Total	Body	Teg. L.	Teg. W.	Wgs.>Teg.	H. fem.	Ant.	Pron.	Ovip.
Male...	35–42	18–20	22–32	5.5–7	4.5–6	18.5–23	27–40	4–5	
Female.	32–39	14–21	24–29	5.7–6.5		19.5–22	25	4.6	6 mm.

The male of this species is distinguished at once by the peculiar genitalia; the female is likely to be mistaken for that of the small northern race of *S. curvicauda*, but with discrimination the narrow tegmina and small ovipositor should characterize it sufficiently to prevent errors.

This is the smallest and commonest Bush-katydid in New England. It lives in tall grasses, bushes, clumps of bayberry, huckleberry, etc. I have found it plentiful coastwise, at Provincetown and Nantucket, in early September. My New England specimens were taken between July 26 and October 10. In New Jersey, Rehn and Hebard state that it appears about a month later than *S. curvicauda*.

It is a very widely distributed species, being known from Brunswick and Norway, Me., to the Pacific coast, and southward to Florida and Mexico, where it develops an additional race.

Concerning its musical performances, Allard says: "This katydid stridulates during afternoons and less frequently at

night. Its call is delivered only at long and irregular intervals so that much patience must be exercised to locate a singer." The song consists of a "keen, incisive *zeep*, or sometimes three slowly in succession—*zeep, zeep, zeep.*" Riley records that the call is occasionally responded to by a faint chirp from the females, produced by stretching out their wings as if for flight.

The method of oviposition has been interestingly described by Riley: "The female stations herself firmly by the middle and hind legs on twigs or leaves contiguous to the one selected to receive the eggs. This leaf is then grasped by the front feet and held in a vertical position, while the edge is slightly gnawed or pared off by the jaws to facilitate the entrance of the point of the ovipositor. When this is done the abdomen is curved under and brought forward, and the ovipositor is seized on its convex edge by the mandibles and maxillae, which, with the aid of the palpi, guide the point to that portion of the leaf prepared to receive it. After gentle, but repeated efforts, the point of the instrument is finally inserted between the tissues of the leaf, and gradually pushed in to more than half its length. As soon as the cavity is formed, the egg is extruded, and passed slowly between the semi-transparent blades of the ovipositor. As the egg leaves the ovipositor the latter is gradually withdrawn, while the egg remains in the leaf, retained in place, probably, by a viscid fluid that is exuded with it. As many as five eggs are sometimes deposited in one row in the same leaf, but more often they are single."

European Bush-katydid.

Leptophyes punctatissima (Bosc).

Locusta punctatissima Bosc, Actes Soc. d'Hist. Nat. Paris, tab. 1, p. 44, pl. 10, figs. 5, 6 (1792).

Leptophyes punctatissima Brunner, Prod. d. Europ. Orth., p. 285 (1882); Fernald, Psyche, vol. 14, p. 120 (1907).

Head broad and short with prominent spherical eyes. Pronotum very short, truncate before and behind, convex in transverse section, horizontal (♀) or furrowed transversely in longitudinal section (♂) by an anterior and a principal sulcus; lateral lobes short; humeral sinus lacking. Elytra of female convex, rounded apically; of male bent abruptly down at the sides, flat and

deeply rugose above, with a fuscous line between dorsal and lateral fields. Legs slender. Hind femora with from three to five short spines beneath. Abdomen short, compressed, subcarinate above. Subgenital plate of male scoop-like, flattened ventrally, the apex upturned, broad, truncate, with median and lateral carinae. Cerci caliper-like, curving inward on apical third, sometimes hidden in concavity of subgenital plate. Ovipositor large, strong, three times as long as broad, curving upward, the dorsal margin a little concave, the ventral strongly arched, the distal half with both margins minutely toothed, the teeth on ventral margin directed forward.

Color: female, green, heavily punctate with brownish black on pronotum and dorsum of abdomen. Male, brown, or brown above with greenish face, sides of body, and legs. Described from two males, one female, dried examples, from Nantucket, Mass. European specimens are said to turn brown in drying; Finot records a brown variety from the Pyrenees.

Measurements.

	Body	Pronotum	Tegmina	Hind femora	Antenna	Ovipositor
Male	14	2.5	3–3.5	14	37–40	
Female	14	2.75	2	14		6 mm.

A male and female of this curious little flightless European Katydid were captured on Nantucket by Professor H. T. Fernald of Amherst, Mass., September 5 to 10, 1907. They were sent to me for identification and duly recorded by Professor Fernald (Psyche, vol. 14, p. 120, 1907). In September, 1913, while visiting the island I found a male in the collection of the Maria Mitchell Scientific Association. These are all the New England specimens known to exist.

This species was undoubtedly introduced into this New England locality with shrubs, trees, or other plants from nurserymen, but whether it has established itself completely and is still living on the island remains to be learned. I did not find it in 1913 but the time spent was very limited and the weather unfavorable.

It is widely distributed in Europe and not uncommon in England, living on trees, brambles, etc. It is said to come out into view after wind or in sunshine. The eggs are laid in crevices in the bark of trees, the young hatch in May, and the adults appear

in autumn, when they are taken by sweeping, and sometimes are captured at the sugar-baits for moths.

The Katydid; Broad-winged Katydid; Leaf-winged Katydid.

Pterophylla camellifolia (Fabricius).

Figs. 51, 52.

Locusta camellifolia Fabricius, Syst. Ent., p. 283 (1775).
Platyphyllum concavum Harris, Treatise, 3d ed., p. 158, fig. 74 (1862).
Cyrtophyllus concavus Smith, Rept. Ct. Bd. Agric. for 1872, p. 356 (1873).—Scudder, Boston Journ. Nat. Hist., vol. 7, p. 444 (1862).—Fernald, Orth. N. E., p. 104 (1888).
Cyrtophyllus perspicillatus Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 131 (1911).

Body large, robust. Tegmina very broad, concave, completely enclosing the wings and abdomen, with a very prominent middle

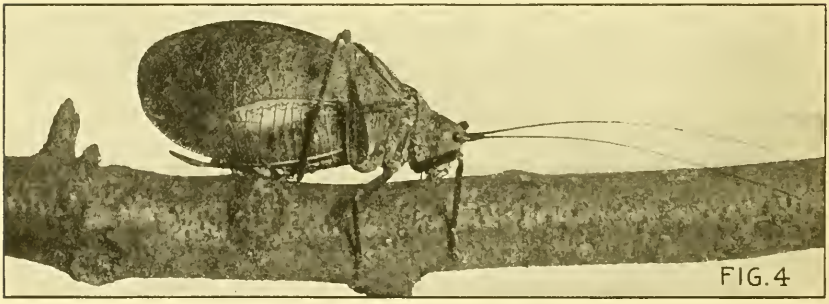


Fig. 51.—The Katydid, *Pterophylla camellifolia*. Side view. (After Walden.)

vein, coarsely and rather regularly reticulated, especially the anterior field in the male. The musical organs of the male are conspicuous. They consist of a pair of taborets, "formed by a thin and transparent membrane stretched in a strong half-oval frame in the triangular overlapping portion of each wing-cover" (Harris), much depressed below the marginal framework. The head is broad and short, with small globose eyes and pointed vertex shallowly excavate above and emarginate on the face between the bases of the antennae. The jaws are exceptionally large and strong, with a formidable row of prominent teeth.

Antennae nearly twice the length of the body, tapering gradually, greenish. Pronotum broad, short, rugose, with two conspicuous transverse grooves and upturned dorsal hind margin, without noticeable lateral carinae. Front and middle legs of moderate length, hind legs short and relatively weak, the creature traveling chiefly by crawling rather than leaping. Subgenital plate of male greatly elongated into a narrow, grooved, tongue-like organ, slightly upcurved, shallowly excavate above, with an acute, slightly bifurcate tip. Cerci of male grapple-like, consisting of two narrow prongs from a broad base, the upper lying above the subgenital plate, curved and tapering to a delicate upturned black tip, the lower and stouter of the two projecting downward and bent abruptly inward, terminating in a strong black-tipped point lying beneath the subgenital plate. Ovipositor four to five times as long as wide, scimitar-like, curving gently upward to an acutely pointed, finely serrulate tip.

The color is a rather dull leaf green, darker on the tegmina, paler on the legs, and nearly white beneath, the stridulatory area of the male brownish purple. The colors of the fresh insect change to a dull yellowish or brownish green after death.

Measurements.

	Total	Tegmina	Hind femora	Antenna	Subg. pl.	Ovipositor
Male.....	39–42	34 x 17	18–19.5	65–70	12.5	
Female.....	41–42	34 x 13	19			15 mm.

This insect is the Katydid of song and story, so named from its peculiar stridulating cry, which consists of from two to four syllables of most raucous quality, variously translated by its hearers into *Katy, Katy-did, she did, Katy-she-did.* Primarily a mating call to allure the female to the proximity of the male, it is also used by him defensively. A captured male in my possession, when approached closely by the hand, would promptly elevate his wing-covers and sound the hoarse, rasping cry, a proceeding the effect of which upon an attacking bird may readily be imagined. When actually seized these insects also use the powerful jaws to inflict a severe pinching bite upon incautious fingers.

The note is one of the loudest made by New England Locustarians and may be heard, under favorable conditions, at a

distance of a quarter-mile or even farther when a number of individuals are performing in chorus. It is repeated at short intervals for hours together, from early dusk to dawn. It may be heard frequently even in the middle of the day on warm cloudy days and late in the season.

Scudder speaks of it as follows: "The note, which sounds like *xr*, has a shocking lack of melody; the poets who have sung its praises must have heard it at the distance that lends enchantment. In close proximity the sound is excessively rasping and grating, louder and hoarser than I have heard from any other of the Locustarians in America or in Europe, and the Locustarians are the noisiest of all Orthoptera. Since these creatures are abundant wherever they occur, the noise produced by them, on an evening specially favorable to their song, is most discordant. Usually the notes are two in number, rapidly repeated at short intervals. Perhaps nine out of ten will ordinarily give this number; but occasionally a stubborn insect persists in sounding the triple note—(*'Katy-she-did'*); and as katydids appear desirous of defiantly answering their neighbors in the same measure, the proximity of a treble-voiced songster demoralizes a whole neighborhood, and a curious medley results; notes from some individuals may then be heard all the while, scarcely a moment's time intervening between their stridulations, some nearer, others at a greater distance; so that the air is filled by these noisy troubadours with an indescribably confused and grating clatter."

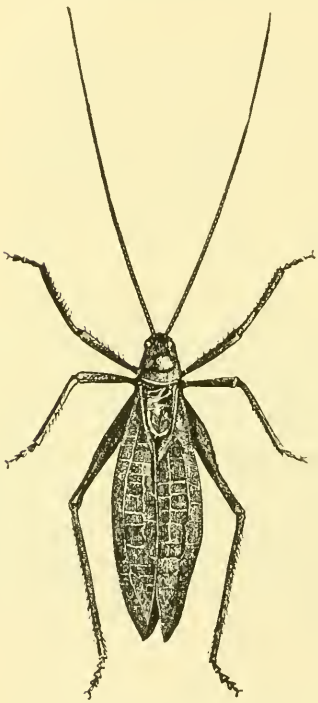


Fig. 52.—The Katydid, *Pterophylla camellifolia*. Dorsal view. (After Lugger.)

The Katydid is an arboreal insect, living in colonies in groves of trees about houses, in parks, or locally in parts of extensive

wooded areas, these colonies persisting for many years. For a long time a thriving colony maintained itself on the college grounds at Wellesley, but the wholesale application of poison sprays to combat the gipsy moth finally destroyed the Katydids. Most of the colonies which I have noted have been located in oak or mixed woods, but I have found them also in elm and apple trees near houses. Owing to its retiring habits by day, and usual preference for the higher limbs of trees, it is seldom seen, though its raucous cries are known to nearly everyone living in southern New England. These are heard in September and October, the last singers persisting with increasing feebleness, until killed by heavy frosts.

The eggs are said by Harris to be slate-colored, rather more than one-eighth of an inch in length, resembling tiny oval bivalve shells. "The insect lays them in two contiguous rows along the surface of a twig, the bark of which is previously shaved off or made rough with her piercer. Each row consists of 8 or 9 eggs placed somewhat obliquely, and overlapping each other a little, and they are fastened to the twig with a gummy substance. In hatching the egg splits open at one end, and the young insect creeps through the cleft."

The Katydid is locally plentiful throughout Connecticut and in the warmer parts of Massachusetts. Extralimitally the species is found in most of the States east of the Great Plains.

THE CONE-HEADED GRASSHOPPERS—NEOCONOCEPHALUS.

These are large, extremely long-bodied Grasshoppers with conical heads, short weak legs, and long, straight or slightly curved sword-like ovipositors. They attract attention at once by their bizarre appearance, due largely to their exceedingly elongate form, which, combined with their delicate coloring is decidedly protective, living as they do among the stems of coarse grasses. The color is prevailingly a soft green, varied with small amounts of black, pink, and purple, but a brown coloration replaces the usual green in varying numbers of individuals in nearly every species.

They are sluggish insects with feeble leaping powers and seldom fly far, usually seeking escape from danger by plunging downward and hiding themselves in the maze of stems and leaves at the

base of the tufted growth of grasses amid which they live. Here also the eggs are deposited, the ovipositor being thrust down between the sheath and stem of a coarse grass, such as Andropogon. Their stridulating powers make them well worth seeking out, one species in particular, common coastwise, being notable for the strident, piercing quality of its song, which renders it audible at a long distance. Four species inhabit New England, and adventive examples of another are occasionally introduced with garden truck.

Key to Species of Neoconocephalus.

A. Vertex of head short, equal to or less than width between eyes above, usually margined with black beneath.

B. Ovipositor of female much longer than hind thighs. Size small, slender. Cone of vertex distinctly longer than wide, the sides sub-parallel.
Round-tipped Conehead, *N. retusus*, p. 356.

BB. Ovipositor of female shorter—or barely longer—than hind thighs. Size large, robust. Cone very blunt, its length scarcely exceeding its width at base.
Blunt-tipped Conehead, *N. triops*, p. 358.

AA. Cone of head longer than width between eyes above.

C. Cone tapering, rather blunt, without black marking beneath.
Robust Conehead, *N. robustus*, p. 355.

CC. Cone of moderate length, margined beneath with black Λ-shaped marking.....The Sword-bearer, *N. ensiger*, p. 354.

CCC. Cone very long, its entire under side black to basal tooth.
Unmusical Conehead, *N. exiliscanorus*, p. 357.

The Sword-bearer; Coneheaded Grasshopper.

Neoconocephalus ensiger (Harris).

Fig. 53; Plate 12, figs. 5, 6; Plate 15, figs. 11, 15.

Conocephalus ensiger Harris, Rept. Ins. Mass. Inj. to Veget., p. 131 (1841); Treatise, 3d ed., p. 163 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 359 (1873).—Fernald, Orth. N. E., p. 22 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 133 (1911).

Grass green, paler on the face, yellowish on abdomen beneath. A pale line on the lateral carinae of the pronotum, often faintly bordered with purple. Antennae purplish. Cone of vertex of head with black Λ-shaped marking beneath, bordered laterally by a pale line which is continued backward to the pronotum;

another narrow pale line runs backward from the eye. Mouthparts more or less purple, brightest on the labrum; tips of mandibles, labium, hind tibiae, and all tarsi brownish purple.

Measurements.

	Total	Body	Tegmina	Hind fem.	Antenna	Ovipos.	Teg.>H. fem.
Male	45–50	23–27	36.5–39	18–20.5	28–33		14–17
Female....	53–61	27–31	43 –50	20–23	28–33	28–33	20–23 mm.

This is our commonest—and, in New England, the most widely distributed—Coneheaded Grasshopper. It lives in cornfields and in grasslands, either dry or moist, but not marshy. Its distribution extends from Norway in southwestern Maine, southward to Philadelphia, the mountains of North Carolina, and west to North Dakota and Colorado.

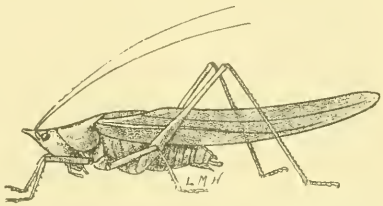


Fig. 53.—The Sword-bearer, *Neoconocephalus ensiger*. Male. (After Lugger.)

It matures in late July or early August, and is common throughout the latter month and most of September. Brown individuals are not rare but are greatly outnumbered by green. The note which it produces is not loud but is heard constantly where the species is numerous. It has been described as a soft and lisping *tzip, tzip, tzip, tzip,* rapidly repeated for indefinite periods.

Robust Conehead.

Neoconocephalus robustus (Scudder).

Plate 15, figs. 1–4, 17.

Conocephalus robustus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 449 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 359 (1873).—Fernald, Orth. N. E., p. 23 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 135 (1911).

Measurements.

	Total	Body	Tegmina	Hind fem.	Antenna	Ovipos.	Teg.>H. fem.
Male	51–56.5	29–31	40–44.6	23–24	38–42		13–18
Female....			49.6	26.4		26.7	

This is a stout-bodied Conehead which is not uncommon coastwise in New England from Cape Cod southward in August and

September. Extralimitally it extends to Philadelphia, and Ocean View, N. J., where it intergrades with a larger southern race. It frequents cat-tail marshes and sand-grass areas near the coast, and makes its presence known, especially where numerous, by the astounding racket it produces when stridulating, which has been admirably described by Scudder. "The song resembles that of the harvest-fly, *Cicada canicularis*. It often lasts for many minutes, and seems, at a distance, to be quite uniform; on a nearer approach, one can hear it swelling and decreasing in volume, while there is a corresponding muscular movement from the front of the abdomen backward, two and a half times a second. This is accompanied by a buzzing sound, quite audible near at hand; it resembles the humming of a bee, or the droning of a bagpipe." Rehn and Hebard speak of it as follows: "The song of this insect is a very loud and continuous buzzing which is very penetrating and usually audible to a distance of at least 600 feet. This song is given loudly and persistently after dark; rarely lone individuals will be heard singing lustily even on clear days as early as four o'clock. During the day males sometimes at long intervals give a short hesitating and irregularly harsh note which would not be readily associated with their song. . . . This day song, or what might well be termed sleep-song, is in reality a brief and drowsy impulse giving just sufficient energy to the act of stridulation to demonstrate the sound produced when the vibrations are not at full speed, the irregularity of the sound resulting from the same cause. . . . While stridulating the males frequently rest head downward, occasionally moving nervously about without ceasing their song."

Round-tipped Conehead.

Neoconocephalus retusus (Scudder).

Plate 15, figs. 5–10, 16.

Conocephalus retusus Scudder, Proc. Boston Soc. Nat. Hist., vol. 20, p. 93 (1879).

Conocephalus triops Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 135 (1911).

Small, slender, with blunt-tipped, rather narrow, and parallel-sided vertex. Ovipositor long, greatly exceeding the hind femora

and far surpassing the ends of the closed tegmina, straight or curving gently but decidedly upward.

Measurements.

	Total	Body	Tegmina	Hind fem.	Ant.	Ovip.	Ovip. passes Teg.
Male.....	38–43	23–26	31–34	17–22	35–40		
Female....	39–48	23–28	30–38	19–25.5	35–	25–35	5–13 mm.

This is a common species locally at least, in southern Connecticut, where it has been taken from August 29 to October 3 at New Haven and Westville. Walden found it "in tall grass along a ditch which contained water only in wet seasons" and I am indebted to him for the opportunity to study a series of specimens.

Rehn and Hebard speak of it as follows: "It is an inhabitant of the grasses in waste fields, along the borders of marshes and in the drier portions of the marshes proper, and is usually to be found in large numbers. The song is . . . a continuous *zĕĕĕĕĕĕĕĕĕĕĕ*. In New Jersey the species is the last of the genus to appear, reaching the adult condition toward the end of August." Beyond our borders it extends to Florida, Mississippi, Tennessee, and Missouri.

Unmusical Conehead.

Neoconocephalus exiliscanorus (Davis).

Plate 15, fig. 18–22.

Conocephalus exiliscanorus Davis, Can. Ent., vol. 19, p. 57 (1887).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 134 (1911).

Measurements (from N. Y. and N. J. specimens).

	Total	Body	Tegmina	Hind femora	Ovipositor	Vertex
Male.....	—	—	33.1–46.5	19.3–24.8		4.2–6.1
Female	—	—	40.1–50.7	23.9–30.4	35–47	5.3–7.2 mm.

A single specimen of this Conehead is recorded by Walden from New Haven, Ct. It is common in the vicinity of New York, where captures are recorded from early in August onward, and extends to Georgia and Texas.

The species is described as very local but often found "in large numbers in the heavier tangles of weeds, low bushy plants or heavy reeds in both fresh and saltwater marshes." The "song is rather loud—'*ziit, ziit, ziit,*' a vibrant rattling note rising and

falling in intensity, often ceasing as from exhaustion. The number of consecutive times without pause that this sound was produced were on one occasion counted, 26–14–20–20–17; usually on a warm evening an undisturbed singer would average about as above before ceasing for a few seconds. The song is rapid, the sounds being emitted on warm evenings about three to the second. When near a colony of this species on favorable evenings after dark the air is vibrant with the sound; as several singers cease others take up the constantly rising and falling song, but at no very great distance the sound is inaudible. The insects were found not to begin to sing until nearly sunset and before dark often ceased their song upon any attempt to approach the spot; after dark the singing was much more vigorous and the singers could then often be approached with a light and cautiously seized while singing and moving about in the bushy weeds and heavy grasses into which they climbed while stridulating" (Rehn and Hebard).

Blunt-tipped Conehead.

Neoconocephalus triops (Linné).

Gryllus (Tettigonia) triops Linné, Syst. Nat., ed. 10, vol. 1, p. 430 (1758).

Measurements.

	Total	Tegmina	Hind femora	Ovipositor	Teg.>Ovip.
Female.....	51–63	43–53	23–28	21–27	5–9 mm.

Males average a little smaller.

This is a large, robust species with very blunt vertex margined with dusky beneath. The ovipositor is about equal to the hind femora in length, straight, much exceeded by the closed tegmina. The head and pronotum are exceptionally broad and heavily built.

This is a southern species, of purely adventitious occurrence in New England, two examples of which have been captured here in the winter season, one at West Newton, Mass., March 11, 1898, in a dwelling-house, alive, in spinach greens (H. W. Burrison); the other at Danvers, Mass., January, 1916 (L. W. Jenkins), likewise in a house, doubtless having been introduced with similar material. Its habitat is from southern New Jersey and Washington, D. C., to Florida, Texas, and across the continent to southern California.

THE LARGER MEADOW-GRASSHOPPERS—ORCHELIMUM.

This genus is closely related to *Conocephalus* (*Xiphidium*), from which group our three species are readily distinguished by their larger size, more robust body, and stouter ovipositor. The stridulating area of the male tegmina is larger proportionally and is transparent as in that genus. The scientific name, meaning literally, "I dance in the meadow," is especially fitting, in relation to their habitat, their active and energetic locomotion, and their musical performances; one species, indeed, is a noticeable and persistent songster of the sultry days and nights of late July and August, and is often referred to in the literature of insect stridulation.

Key to Species of Orchelimum.

A. Robust species. Cerci of male stout, the distal part not exceeding in length the internal tooth, and with dorsal tubercle.

B. Humeral sinus of pronotum distinct, deep. Cerci of male with internal tooth shorter than distal part of shaft; dorsal tubercle on shaft about one-fourth its length from tip. Ovipositor not strongly widened in middle, distinctly upcurved, its dorsal margin concave.

Common Meadow-grasshopper, *O. vulgare*, p. 359.

BB. Humeral sinus of pronotum barely indicated. Cerci of male with tooth as long as distal part of shaft; dorsal tubercle on shaft about one-third its length from tip. Ovipositor much widened in middle, the dorsal margin straight except at base, the ventral margin strongly convex.....Bruner's Meadow-grasshopper, *O. gladiator*, p. 361.

AA. Slender. Tegmina and wings narrow, elongate. Face usually with a median dusky patch. Pronotum in side view as deep as long. Cerci of male with distal part of shaft longer than internal tooth, not tuberculate above. Ovipositor moderately stout, gently upcurved, half as long as hind femora. A salt-marsh species.

Dusky-faced Meadow-grasshopper, *O. concinnum*, p. 362.

Common Meadow-grasshopper.

Orchelimum vulgare Harris.

Figs. 54, 55; Plate 15, fig. 27–30.

Orchelimum vulgare Harris, Ins. Inj. to Veg., p. 130 (1841); Treatise, 3d ed., p. 162 (1862).—Scudder, Journ. Boston Soc. Nat. Hist., vol. 7, p. 452 (1862); in Hitchcock, Geol. N. H., vol. 1, p. 368 (1874); Appalachia, vol. 8, p. 317, (p. 19 sep.) (1898); 23d Ann. Rept. Ent. Soc. Ontario, p. 73 (1893). —Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, pp. 358, 380 (1873).—Fernald, Orth. N. E., p. 24

(p. 108) (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 139 (1911).—Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 41, p. 38 (1915). All of these references except the first and the last *may* refer to *O. gladiator* Bruner.

Orchelimum glaberrimum Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 139 (1911).—Fernald, Orth. N. E., p. 25 (109) (1888).

Orchelimum agile Scudder, Psyche, vol. 9, p. 103 (1900).

This is a medium-sized species, with stout body and relatively broad tegmina which usually extend 2 to 3 mm. beyond the hind femora, often only equalling them, rarely falling short, or considerably elongated and surpassing them by 5 or 6 mm. The wings usually pass the tegmina in the female, equal them in the male.

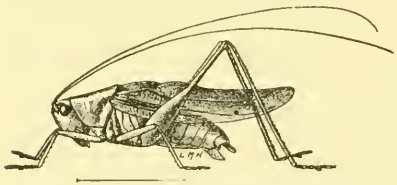


Fig. 54.—Common Meadow-grasshopper, *Orchelimum vulgare*. Male. (After Lugger.)

Color: light grass-green, sometimes with a pinkish over-tint, often turning brown in drying; a mid-dorsal brown stripe on top of head, widened and margined with whitish on pronotum, and represented by brownish spots enclosing the speculum of the male.

Measurements.

	Total	Body	Tegmina	Ovipositor	Pronotum	H. fem.	Ant.
Male	25.5–31	16–20	16–23		3.5–4	12.5–16	45–60
Female	27.5–33	16–21.5	17–23	7.5	3.5–4	14 –16	40–50

Until recently this species has been confused with *O. gladiator* and on this account records of its distribution and notes on its habits must be regarded as subject to correction.

It is found most abundantly in tall grasses and dense weedy jungles on moist ground, in meadows and swamps, along brooks and larger streams, the prime requisites of its existence seeming to be moisture and a dense growth of vegetation. In New England, adults appear in the

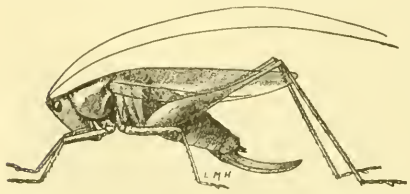


Fig. 55.—Common Meadow-grasshopper, *Orchelimum vulgare*. Female. (After Lugger.)

latter half of July and are found during the remainder of the season.

It is responsible for a large share of the strident insect chorus heard in hot, sultry midsummer days and nights, its song consisting of a series of sharp *zips* followed by a high-pitched *zeeeeeee*.

It is generally distributed and locally common in southern New England, occurring at least from Norridgewock and Brunswick, Me., southward and westward, inhabiting also Nantucket, Martha's Vineyard, and Block Island. Beyond our limits its range extends westward to Montreal, Minnesota, eastern Wyoming and Colorado, and southward to northern Georgia and northeastern Texas.

Bruner's Meadow-grasshopper.

Orchelimum gladiator Bruner.

Plate 15, fig. 23–26.

Orchelimum gladiator Bruner, Can. Ent., vol. 23, p. 71 (1891).—Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 41, p. 44 (1915).

Orchelimum vulgare Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 368, probably (1874); Appalachia, vol. 8, p. 317 (1898).

This species closely resembles *O. vulgare* in size, form, and color, the tegmina averaging longer with reference to the hind femora; it is, however, readily distinguished by a comparison of the pronotum and ovipositor. Having been until recently confused with that species, its stridulation has doubtless been referred to *O. vulgare* and observations on its habits by persons acquainted with both species are needed.

Measurements.

	Total	Body	Tegmina	Hind femora	Ovipositor	Antenna	
Male	21–26.5	16–19	16–20	11–14		42–55	
Female	22–30	24–27	17–23	11–13	7–8	37–45	mm.

It lives in tall grass and rank herbage, in the same environmental conditions as *O. vulgare* and is probably found throughout New England, with the possible exception of southeastern Massachusetts. It has been taken from July 10 to September 8 at Orono and Fryeburg, Me.; North Conway and Alstead, N. H.; Montgomery, Hyde Park, Stowe, and Woodstock, Vt.; Mt. Greylock

summit, 3500 ft., Mt. Washington, and the vicinity of Boston, Mass.; and Stamford, Ct. Extralimitally it extends to southern New Jersey, Tennessee, Kansas, Montreal, Montana, Washington, and northern California.

Dusky-faced Meadow-grasshopper.

Orchelimum concinnum Scudder.

Fig. 56; Plate 15, fig. 31–34.

Orchelimum concinnum Scudder, Boston Journ. Nat. Hist., vol. 7, p. 452 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 380 (1873).—Fernald, Orth. N. E., p. 25 (p. 109) (1888).—Rehn and Hebard, Trans. Amer. Ent. Soc., vol. 41, p. 60 (1915).

Orchelimum herbaceum Scudder, Psyche, vol. 9, p. 103 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 139 (1911).

This is a slender-bodied species with narrow tegmina and wings which usually surpass the hind knees by from 2 or 3 to even 6 or 7 mm. The wings customarily exceed the tegmina 2 or 3 mm. Combined with the narrow thorax the effect of these characters is one of attenuation. The ovipositor usually about reaches the hind knees.

The coloration is apparently affected by its salt-marsh habitat, often being more dusky and olivaceous than that of our other two species, with the sides of the pronotum a vivid bluish green.

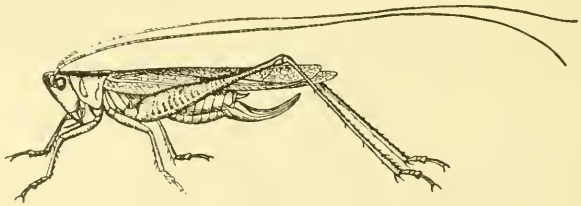


Fig. 56.—Dusky-faced Meadow-grasshopper, *Orchelimum concinnum*. Female. (After Blatchley.)

Above, a dusky stripe usually extends over the face and top of head, dividing into two on top of the pronotum, and is often prolonged backward, suffusing the tegmina in the female or barely indicated about the speculum of the male. This duskiness increases rarely to such an extent as to approach melanism.

Measurements.

	Total	Body	Tegmina	Hind femora	Ovipositor	Antenna
Male.....	25–30	15–18	18–22	14–16		40–58
Female.....	26–32	17–29	19–23	14–16	7	37–55 mm.

This Grasshopper may usually be recognized at once by its slender form, dusky face, and somewhat dingy general coloring, and salt-marsh habitat. In the central part of the country it frequents freshwater marshes as well, but in the eastern States it is found only coastwise. While occasionally met with in the shorter growth of the densely grassed portions of the salt-marsh, it is usually more at home among the tall cord-grass along the tidal runways and ditches and about pools and depressed spots, where, though very local, it often occurs in abundance. Though alert and nimble it is easily captured with the net, and then often shows a secretive disposition in trying to escape notice by remaining quietly hidden among the débris in the net instead of trying actively to regain its freedom.

I am not aware that any account of its stridulation has been published, but observations thereon could readily be made by keeping it captive.

In New England it is known from Rye Beach, N. H. (Hebard), the vicinity of Boston, Cape Cod, Martha's Vineyard, Block Island, and along the coast to Greenwich, Ct. Extralimitally its distribution extends on the Atlantic coast to Florida, and westward to Ontario, Minnesota, Montana, eastern Colorado, and south-central Texas. Adults have been taken in New England from July 22 to September 6, dates which could probably be much extended by persistent collecting, at least in the autumn.

THE SMALLER MEADOW-GRASSHOPPERS—CONOCEPHALUS.

These are the smallest and daintiest of our green or long-horned Grasshoppers, some of the species living in countless numbers in the grass of wild meadows, marshes, and the moister parts of mowing-fields. Their stridulation in such places, under favorable conditions, is almost incessant, and often attracts attention. Much has been written about their songs, but in the published accounts the insects are usually referred to the genus *Xiphidium* or *Xiphidion*, a name formerly in general use for them,

not *Conocephalus*, which was then applied to the Coneheads (now *Neoconocephalus*).

Key to Species of Conocephalus.

Males.

A. Tegmina reaching or passing end of hind thighs, usually exceeded by wings (very rarely reaching only to end of body). Cerci green, rather slender; the apex but little twisted (20° to 30°), in dorsal view rounded, in lateral view taper-flattened on dorsal side; tooth a black, slender, claw-like process on a broad, conical green base.
Slender Meadow-grasshopper, *C. fasciatus*, p. 364.

AA. Tegmina and wings reaching about to end of body. Cerci stout.

B. Cerci brown, with inner tooth stout, conical, its base equal to its height, acutely tipped; apex of cerci usually strongly twisted (60° to 75°), abruptly flattened on dorsal side to a thin plate, in dorsal view subtriangular, one and one-half times as long as broad, apex subacute.
Short-winged Meadow-grasshopper, *C. brevipennis*, p. 366.

BB. Cerci green with inner tooth slender, its height two or three times its basal diameter; apex less twisted and less abruptly flattened, in dorsal view twice as long as broad, apex rounded.
Salt-marsh Meadow-grasshopper, *C. spartinae*, p. 367.

AAA. Tegmina covering only one-half to two-thirds of the abdomen. Cerci rather slender, straight, with conical apex.
Wingless Prairie-grasshopper, *C. saltans*, p. 368.

Females.

A. Tegmina reaching or passing end of hind thighs, usually exceeded by wings.
Slender Meadow-grasshopper, *C. fasciatus*, p. 364.

AA. Tegmina and wings about equal to body.

B. Ovipositor with dorsal margin typically straight, shorter than body, sometimes equalling it.
Short-winged Meadow-grasshopper, *C. brevipennis*, p. 366.

BB. Ovipositor typically curved upward, gently arcuate, shorter than body.
Salt-marsh Meadow-grasshopper, *C. spartinae*, p. 367.

AAA. Tegmina only two-thirds as long as pronotum, wings abortive. Ovipositor equal to the body, gently arcuate.
Wingless Prairie-grasshopper, *C. saltans*, p. 368.

Slender Meadow-grasshopper.

Conocephalus fasciatus (DeGeer).

Plate 15, fig. 37.

Locusta fasciata DeGeer, Mém. Hist. Ins., vol. 3, p. 458 (1773).
Orchelimum gracile Harris, Treatise, 3d ed., p. 163 (probably, but not the figure) (1862).

Xiphidium fasciatum Scudder, Boston Journ. Nat. Hist., vol. 7, p. 451 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 358 (1873).—Fernald, Orth. N. E., p. 24 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 137 (1911).

This is a slender-bodied and typically long-winged species, with tegmina nearly always passing the end of the hind thighs and usually exceeded slightly by the wings. Cerci green, rather slender, the apex but little twisted, in dorsal view rounded, in side view flattened on dorsal side, tapering to a point. Ovipositor straight, slender, two-thirds as long as hind femora; green, shaded with brown toward tip.

Color: rather light grass-green, a dark rufous-brown stripe from vertex of head to hind margin of pronotum, widening backward. Sides of face and pronotum and all femora with minute brown dots. Tibiae and tarsi, especially the hinder pair, suffused with brown. Dorsum of abdomen with a median solid dark brown stripe bordered by a pair of dorso-lateral yellowish or whitish stripes which are margined in turn by a pair of more or less distinct brown stripes. Abdomen beneath bright green in life, yellowing when dried.

Measurements.

	Total	Body	Tegmina	Hind femora	Ovipositor	Antenna
Male.....	16–17	12–14	10–12	9 –10.5		28–32
Female.....	18–21	13–15	13–14	10.5–11.5	6–7	27–32 mm.

Rarely short-winged examples are found with tegmina but 6 mm. long.

This graceful little species is our most common Meadow-grasshopper and occurs throughout New England. It is a denizen of the ranker growth in the damper parts of grass-covered fields, pastures, and meadows and the tangles of herbage at their edges, where it is often exceedingly abundant locally, both inland and at the margins of the coastwise salt-marshes. It takes wing readily when alarmed, but its flight is seldom more than a yard or two in length. Adults appear about the middle of July and are found during the remainder of the season.

Allard says that it is a persistent singer by day and night but its stridulation is among the faintest known to him, the notes of captive individuals even in the quiet of a room being barely audible seven or eight feet away. The song "invariably begins

with a succession of very faint notes *tse-tse-tse* repeated very slowly and terminating with the phrase *tse-e-e-e-e-e-e-e-e-e-e-e-e-e* which continues from five to twenty seconds. . . . So brief and faint are the preceding notes, however, that they may be readily overlooked." McNeill says of it: "Its song is a faint echo of that of *Orchelimum vulgare*. . . . Its faint little quaver is the first note of the great chorus that sounds in all the meadows from the first of August till the first of October or until cold weather."

Its range extends from Prince Edward Island to Manitoba, southern Florida, and Mexico.

Short-winged Meadow-grasshopper.

Conocephalus brevipennis (Scudder).

Plate 15, fig. 35.

Xiphidium brevipennis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 451 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 358 (1873).

Xiphidium brevipenne Fernald, Orth. N. E., p. 24 (1884).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 137 (1911).

A small, stout-bodied Grasshopper with tegmina and wings barely covering the body(♂), or two-thirds of it (♀) (very rarely, it is said, they are of full length). Cerci of male brown, stout; the apex usually strongly twisted (60°–75°), in side view rounded, in dorsal view pinched apically, in dorso-lateral view abruptly and strongly flattened on dorsal side to a thin plate. Ovipositor dark brown, typically straight on dorsal margin, shorter than body, sometimes equalling it.

Grass-green, minutely dotted with brown on sides of face, pronotum, and legs. A moderately broad, dark-brown stripe extends from vertex of head to hind margin of pronotum, and is narrowly bordered laterally on the pronotum with whitish. Tegmina brown. Dorsum of abdomen brown, sometimes broken by indications of pale stripes on each side of the broad median band. Hind femora with two narrow longitudinal stripes of brown. End of abdomen of male beneath yellowish or brownish.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor	Antenna
Male	10.4–14	6–8	8 –11		36–43
Female	11.5–15	7–9.5	10.5–12	7–8	30–37 mm.

This little Grasshopper is a very common resident of herbaceous weedy jungles on damp soil and the more rankly growing grass of mowing-fields. Adults begin to appear in the latter half of July, and linger until killed by hard frosts. The young are to be found much earlier, in late May or early June, tiny, soft-bodied green midgets with black dorsal stripe and enormously long and sensitive antennae whose fragility is so great that it is a constant marvel how the little creatures retain them in an undamaged condition.

It is abundant in suitable localities throughout southern New England; it is known from Eastport, Me., Jefferson, N. H., and Woodstock, Vt., and its range very likely extends even farther north. Extralimitally it is recorded from Quebec, Minnesota, Texas, and Florida.

Salt-marsh Meadow-grasshopper.

Conocephalus spartinae (Fox).

Plate 15, fig. 36.

Xiphidium spartinae Fox, Ent. News, vol. 23, p. 111, text-figs. 2, 5; pl. 8, fig. 1–6 (1912).

Cerci moderately slender, about four times as long as broad, their sides nearly parallel, the apex rounded, blunt, and strongly flattened on its upper side. The interno-ventral tooth is shorter and much slenderer than in *C. brevipennis* and a tuberosity lies above its base (*cf.* Pl. 13, figs. 35, 36); in side view their middle portion appears nearly equal, as compared with the swollen outline in *C. brevipennis*. Ovipositor gently but distinctly arcuate, about five-sixths as long as hind femora, three-fourths or five-sixths as long as the body.

General color in life a vivid, faintly bluish green, shining; the terminal half of the abdomen conspicuously light orange, cerci green; midline of head and pronotum broadly marked with chestnut, darkening anteriorly. The green is frequently largely or wholly replaced by brownish or dusky, as in *Orchelimum concinnum*, another salt-marsh species. In drying, most specimens discolor badly, becoming brownish.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	10.5–12	7 –8.5	9.5–10.5	
Female	11 –14	7.5–8.5	11.5–11.7	8–9.3 mm.

This species closely resembles *C. brevipennis* in appearance and size, differing from it especially in the curved ovipositor of the female and the structure of the male cerci, but also in the typically wider tympanal area and the crowded position of the teeth on the inner half of the stridulating ridge of the male tegmina.

This little brightly colored Grasshopper has been captured only on salt-marshes and in their immediate vicinity. Fox, the first to distinguish it, reported it to be "abundant on the short Spartina" grass "covering the tidal flats. Less frequently it was found on the black-grass, *Juncus gerardi*, one of the characteristic plants of the lowlands bordering the marshes on the upper side. Only rarely does it appear to stray inland and then only to that part immediately adjoining the salt-marsh."

It is a sluggish species, usually common where found, and the vivid and strongly contrasting hues of the typical color variety enable it to be readily recognized. Nothing is known relative to its stridulation; the apparatus is said to differ slightly from that of *C. brevipennis* but it is doubtful whether human ears would be able to discriminate between the two.

It was described originally from Woods Hole, Mass., and southern New Jersey. Numerous specimens from Cape Cod are in the Scudder collection. I have taken it at Niantic and Stamford, Ct.; Faneuil Station, Mass., before the creation of the Charles River Basin and the change of that portion of the river from brackish to fresh water; Rowley, Mass.; Brave Boat Harbor and York Beach, York, Me.; and Pine Point near Old Orchard, Me. It has an extensive distribution along the southern seaboard, reaching Georgia, Florida, and Louisiana, where long-winged examples are not uncommon. Dates of New England captures range from July 22 to September 20.

Wingless Prairie-grasshopper.

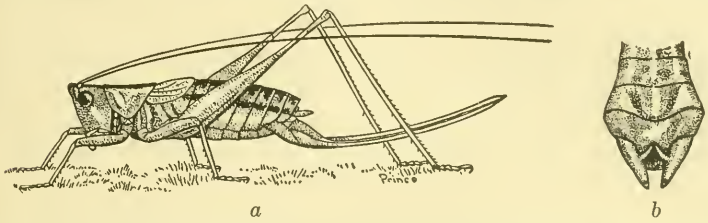
Conocephalus saltans (Scudder).

Fig. 57; Plate 15, fig. 38.

Xiphidium saltans Scudder, Rept. U. S. Geol. Surv. Nebraska, p. 249 (1871). —Blatchley, 27th Ann. Rept. Dept. Geol. Nat. Resources Ind., p. 377 (1903).

Tegmina of the male covering only one-half or two-thirds of the abdomen; of the female distinctly shorter than the pronotum.

Ovipositor nearly as long as the body, gently but distinctly arcuate, slender, very gradually tapering toward the end. Cerci of the male rather short, straight, the apex conical, tapering to



a *b*

FIG. 57.—Wingless Prairie Grasshopper, *Conocephalus saltans*. *a*, female, ×2⅔; *b*, tip of male abdomen, showing form of cerci. (After Blatchley.)

a rounded point; the inner tooth placed nearer the tip than the base, equal to the apex in length (four times its basal diameter), sharp, gently recurved. Paired processes of hind margin of supra-anal plate larger, more prominent, and more widely separated than in *C. brevipennis* and *C. spartinae*.

General color very pale reddish with darker brown median stripe on head, thorax, and exposed abdomen, often bordered laterally by narrow pale stripes, and clouded with brownish on sides of abdomen. Sides of thorax and face greenish.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	11–12	4–5	10–11.5	
Female	10–13	2	10–11.5	9.5–11 mm.

This is a slender-bodied little Grasshopper, of which the female, owing to the diminutive tegmina, strongly resembles an immature individual and is likely to be passed by as such. While not absolutely deprived of organs of flight, the vernacular name proposed for the species is not far amiss, since these are of such small dimensions as to be quite useless for that purpose. The less degenerate condition of the tegmina in the male is probably to be explained by their use as stridulatory organs.

The only New England locality for this species at present known is the island of Nantucket, where I found it not uncommon at widely separated points on the sandy moors in early September, 1913, among *Andropogon* and other xerophytic grasses and wild

indigo (*Baptisia tinctoria*) and scattered clumps of huckleberry bushes (*Gaylussacia*). Search should be made for it on Martha's Vineyard and southern Cape Cod. In New Jersey it is found on sandy barrens and it is widely distributed in the central and plains States, always as an inhabitant of wild, unimproved land, and usually on dry soil. It is a relatively sluggish species and is said by Blatchley in Indiana to frequent "the surface of the ground rather than the stems of the tall prairie grasses among which it makes its home." Allard states that in Georgia it prefers luxuriant growths of weeds and grasses in moist bottom lands.

The presence of this flightless species on the island of Nantucket adds another item to the many data supporting the theory that in earlier geologic times a great sandy plain bordered the Atlantic seaboard from Virginia to Newfoundland, providing opportunity for characteristic plants and animals to spread far to the northeast. The present widely isolated colonies of these are to be considered as remnants of a once continuously distributed flora and fauna now surviving only in particularly favorable localities.

THE SHIELD-BACKED GRASSHOPPERS—ATLANTICUS.

The Shield-backed Grasshoppers (*Atlanticus* spp.) are large, brown, wingless, ground-dwelling insects with long hind legs and slender antennae. They live for the most part among the fallen dead leaves, which they closely resemble in color, usually in dry upland woods of either evergreen or deciduous trees. They are not restricted to such situations, however, but have been captured while singing in bushes, in brush-grown pastures, a foot or two from the ground, and in tussocks of grass in swampy fields; occasionally they climb the trunks of trees, attracted by the sweetened baits put out by collectors to lure moths. Since they are chiefly nocturnal in habit, the flashlight and lantern are useful in watching and capturing them; and ground-set molasses-traps suitable for Roaches will often entice them to destruction.

In the South, one species at least is preyed upon by a large fossorial wasp (*Chlorion ichneumoneum*), whose burrows Davis records finding stored with numbers of these insects as food for their young (Journ. N. Y. Ent. Soc., Dec., 1911). Their stridula-

tion, produced by the very diminutive tegmina, is high-pitched and of but little volume, but may be heard by keen ears at a distance of two or three rods.

Although widely distributed these insects are scarce in New England, single examples or at most two or three at a time being met with now and then. Two species only are definitely known to inhabit New England, but a third should be sought for along our western border.

Key to New England Species of Atlanticus.

Hind femora two and one-half times as long as the pronotum. Male with tegmina but very little exposed; cerci acutely tipped and the inner tooth placed about half-way from tip to base. Female with subgenital plate split deeply, the lobes prolonged, sublanceolate.

Long-legged Shield-backed Grasshopper, *A. americanus*, p. 371.

Hind femora only twice as long as pronotum. Male with exposed part of tegmina three-fourths as long as pronotum; cerci blunt at tip, the inner tooth nearer the tip than base. Female with subgenital plate but moderately emarginate, the lobes arcuate, semicircular.

Short-legged Shield-backed Grasshopper, *A. testaceus*, p. 372.

Long-legged Shield-bearer.

Atlanticus americanus (Saussure).

Plate 14, fig. 15–17.

Orchesticus americanus Saussure, Rev. et Mag. de Zool., ser. 2, vol. 11, p. 201 (1859).

Thyreonotus dorsalis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 454 (1862). —Fernald, Orth. N. E., p. 26 (p. 110) (1888).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 380 (1873).—Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 320 (1874).

Atlanticus dorsalis Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 141 (1911).

Head but little prominent, smooth, the vertex narrowing anteriorly between the small round eyes to a blunt decurved ridge which is cut transversely on the face between the antennal pits by a narrow groove. Face broad and rounded. Pronotum prolonged backward over the first abdominal segment, slightly convex above both transversely and longitudinally, the disk broadening backward, convex behind, its sides gently sinuous, carinate at junction with lateral lobes, which are angulate with the disk. Prosternum with a pair of prominent, slender spines.

Tegmina of female hidden under pronotum, of male barely exposed. Hind legs extremely long, two and one-half times as long as pronotum, thighs stout at base. Last dorsal segment of abdomen of male shallowly V-emarginate. Cerci long, straight, acutely pointed, bearing a short, claw-like spur or tooth on the upper inner side. Subgenital plate of female very deeply divided, the two lobes prolonged, sublanceolate. Ovipositor equal to hind femora.

Color: brown, varying from yellowish to ruddy, often with fuscous patches on sides of pronotum and tegmina and minute spots on the abdomen, sometimes arranged regularly in longitudinal or transverse rows. The lateral carinae and the lower edge of the pronotum often distinctly pale.

Measurements.

	Body	Tegmina	Hind femora	Antenna	Ovipositor
Male.....	20–24	2	21–22	34	
Female.....	26–27	0	24–25	35–40	26–27 mm.

This appears to be the more common of our species. It matures late; the young may be found in late June and July, and mature individuals from late July till October. It is definitely known from several points in the vicinity of Boston (Blue Hills, Dedham, Sharon, Turtle Pond Reservation) and from West Chop, Martha's Vineyard. It probably occurs in much of the coastwise part of New England from southeastern Maine to Connecticut and extends extralimitally to Alabama and Mississippi.

Short-legged Shield-bearer.

Atlanticus testaceus (Scudder).

Fig. 58; Plate 14, fig. 11–14.

Engoniaspis testacea Scudder, Proc. Davenport Acad. Nat. Sci., vol. 8, p. 97 (1900).

Thyreonotus pachymerus Fernald, Orth. N. E., p. 26 (p. 110) (1888).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 380 (1873).

Atlanticus pachymerus Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 141 (1911).

Similar in color and general appearance to *A. americanus* but smaller and differing particularly as follows: lateral carina of pronotum straighter; tegmina of female two-thirds as long as pronotum; hind femora only twice as long as pronotum; pro-

sternal spines very short; subgenital plate of female moderately V- or U-emarginate, the sides rounded; cerci of male blunt-tipped, the inner tooth short and rather blunt and placed nearer the end of the cercus.

Measurements.

	Body	Tegmina pass Pron.	Hind femora	Antenna	Ovipositor
Male.....	21	7	15.5	?	
Female.....	21–26	0	18	24	19–21 mm.

In the vicinity of Boston young examples of this species begin to appear in May, and adults in July (juv.,—May 14, South Natick, Mass.; May 24, Dedham, Mass.; adult,—July 10, Sudbury, Mass.; July 23, Sherborn, Mass.). Extralimitally it extends to Virginia and Minnesota.

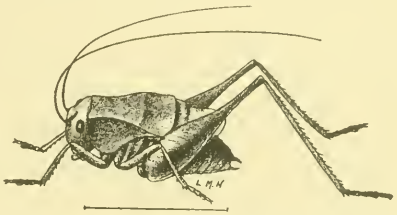


Fig. 58.—Short-legged Shield-backed Grasshopper, *Atlanticus testaceus*. Male. (After Lugger.)

It is quite possible that a third species, *A. davisi*, will be found to inhabit the western border of New England, and that Scudder's record of *A. americanus* (*dorsalis*) from Sudbury, Vt., should be referred to this species as suggested by Rehn and Hebard.

THE CAVE-CRICKETS, CAMEL-CRICKETS, OR STONE-CRICKETS —CEUTHOPHILUS, ETC.

These curious insects have received a variety of names referring to their appearance or habits: Camel-crickets, because of their high, arched back; Cave-crickets and Stone-crickets from their habit of hiding themselves in caves and holes beneath stones, in hollow trees, and similar dark, moist places.

They have relatively soft-walled, hump-backed bodies, lacking even the rudiments of tegmina and wings; extremely long and delicate antennae; and usually long but powerful hind legs and spiny tibiae with which they make prodigious leaps when disturbed. Their coloring is unobtrusive, chiefly of chestnut, chocolate-brown, or fuscous markings on a ground-color of pale yellow,

the pattern varying much and consisting of spots and mottling arranged irregularly or somewhat regularly in either transverse or longitudinal bands. This is quite in keeping with their nocturnal habits, for they shun the daylight, soon crawling away when exposed to it, unless touched, when their powerful but erratic leaps quickly place them in safety.

They differ notably from other members of the family in being apparently quite deaf and dumb, without special organs of hearing or of stridulation, and consequently are less frequently noticed. In diet they are said to be nearly omnivorous, eating dead insects and other animal matter as well as vegetable substances.

Knowledge of our native species is in a chaotic condition, owing partly to lack of material and observations, and partly to errors of discrimination and even downright carelessness on the part of systematists. At least six distinct species of native origin and perhaps more inhabit New England; additional species should be sought in the caverns of the limestone areas along our western border. An exotic species from Asia has been introduced within a few years and maintains itself to the present time in conservatories.

Key to Stenopelmatinae of New England.

I. Vertex of head armed with a pair of short, conical spines pointing forward and downward. Hind tibiae armed above with two rows of slender, appressed spinules arranged in series of 3 to 7 each, the members of each series increasing slightly in length apically.

Asiatic, or Greenhouse Camel-cricket, *Diestrammena marmorata*, p. 375.

II. Vertex of head smooth, rounded. Hind tibiae armed above with four pairs of widely placed, large, movable spines (in addition to those at apex) and between them with numerous stout spinules.... *Ceuthophilus* spp.[1]

A. Eighth dorsal abdominal segment with hind margin smoothly convex, thickened crescentically in rear view, concealing the ninth segment more or less completely. Subgenital plate short, scoop-shaped, with horizontal, semicircular, thickened margin. Hind femora serrate beneath with very numerous close-set denticulations on both edges, only two and a half or three times as long as wide, the lower margin strongly convex and the hind tibiae arcuate correspondingly.

Yellow Cave-cricket, *C. neglectus*, p. 378.

AA. Ninth dorsal abdominal segment with hind margin deeply obtuse-angulately emarginate. Subgenital plate with hind margin bracket-shaped (⌒). Hind tibiae arcuate at base.

Spotted Cave-cricket, *C. maculatus*, p. 379.

[1] This Key applies only to the males of this genus.

AAA. Ninth dorsal abdominal segment with hind margin smoothly convex.
B. Subgenital plate tapering at apex into a pair of small upward- and outward-curling processes. Slender; hind femora slender, four times as long as wide, armed beneath with very numerous short, appressed spinules.....Woodland Cave-cricket, *C. terrestris*, p. 380.
BB. Subgenital plate emarginate posteriorly, bilobate, the lobes broad, their hind margins convex. Hind margin of ninth dorsal segment broadly parabolic convex, of tenth broadly V-emarginate. Stout; hind femora relatively short, with fewer sharp, closely appressed spinules.....Short-legged Cave-cricket, *C. brevipes*, p. 381.
AAAA. Dorsum of ninth abdominal segment extended backward, truncate, with rounded corners. Subgenital plate V-emarginate or bilobate.
C. Spines of hind tibiae dusky at base.
D. Stout; two conspicuous longitudinal blackish stripes on sides of dorsum; hind femora stout, convex beneath, unarmed or with few exceedingly fine denticulations.
Black-sided Cave-cricket, *C. latens*, p. 381.
DD. Rather slender; usually dull-colored; hind femora only moderately stout, their ventral spinules short, weak, widely set, appressed.
Pale-footed Cave-cricket, *C. lapidicola*, p. 382.
CC. Spines of hind tibiae pale at base.
E. Spines of hind femora long, stout, erect. Very large. Subgenital plate V-emarginate.....Slender-legged Cave-cricket, *C. gracilipes*, p. 383.
EE. Spines of hind femora shorter, appressed. Subgenital plate bilobate from rear.....Stygian Cave-cricket, *C. stygius* (probably synonymous with last-named species), p. 383.

Conservatory Camel-cricket; Asiatic Camel-cricket.

Diestrammena marmorata (DeHaan.)

Fig. 59; Plate 14, figs. 18, 19.

Rhaphidophorus marmoratus DeHaan, Bijdragen tot de Kennis der Orthoptera, p. 217 (1842).
Diestrammena marmorata Brunner von Wattenwyl, Verh. Zoöl.-bot. Ges. Wien, vol. 38, p. 299 (1888).—Lugger, Orth. Minn., p. 254, fig. (1898).
Diestrammena unicolor Morse, Psyche, vol. 11, p. 80 (1904).

Head rounded. Vertex with a pair of short, acutely pointed, black spines directed forward and downward. Palpi nearly as long as body, slender. Antennae extremely delicate and very long, five to six times as long as body. Pronotum convex, truncate in front, a little produced behind. Legs very slender, front and middle femora and tibiae approximately equal, as long or half

as long again as the pronotum. Hind femora stout on basal half, tapering rapidly, slender on apical half, one-third longer than body. Hind tibiae equalling or slightly exceeding hind femora. Fore tibiae with two pairs of spines beneath, at the half and a little short of three-fourths; middle tibiae with a single pair of shorter ones at about three-fourths their length. Hind femora with 5 to 6 short rigid spines near middle of inner lower edge; hind tibiae channelled above, each edge armed with several series of spines, 1 to 5 in number, graduated in length, longest apically, the inner dorsal apical spur as long as the first joint of the tarsus (metatarsus). Cerci long and slender, half as long as hind femora, three-fourths as long as ovipositor, clothed with long, very delicate erect pubescence. Supra-anal plate of male nearly semicircular; subgenital plate short, rounded apically, a little upturned. Ovipositor equalling or slightly exceeding body, slender, straight at base, curving gently upward in the apical third to an acutely pointed dorsal apex, the inner valves faintly crenulate on ventral side of tip.

Ground color whitish beneath, pale brown above irregularly marmorate with darker brown or fuscous particularly on hinder edge of thoracic and abdominal segments. Fore and middle femora bi-annulate with dark brown at three-fifths and at tip; hind femora 4-annulate, the basal ring incomplete on inner side. Feet pale, ovipositor bright chestnut.

Measurements.

	Body	Pronotum	Hind femora	Antenna	Cerci	Ovipositor	Palpi
Male.....	16	6.5	19–21	65–95	10		13
Female....	15–18	7.5	20–23	65–95	10	11–13	13 mm.

This species was first reported from North America (Minneapolis, Minn.) by Scudder under this name, and later from Chicago by me as *D. unicolor;* it has also been recorded from many places in Europe by Chopard as the *Tachycines asynamorus* of Adelung. I am informed by Hebard, who has recently gone into the matter, that the species should be called *D. marmorata* though the characters stated by Brunner in his monograph point toward *D. unicolor.*

This insect is a native of eastern Asia, and was probably introduced into this country and Europe with importations of

plants and bulbs among the wrappings of which it would be likely to hide itself and able to travel long distances.

It is a rather large, slenderly built Cave-cricket with extremely long and delicate antennae, palpi, and hind legs, in color daintily

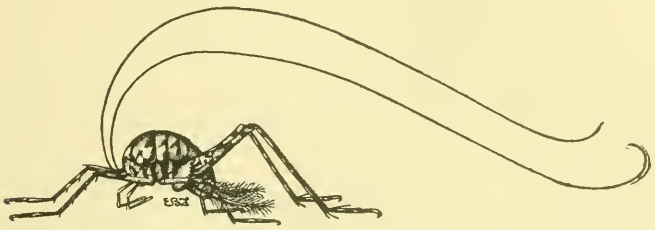


Fig. 59.—Asiatic or Conservatory Camel-cricket, *Diestrammena marmorata*, male. (After Lugger.)

varied with dark markings on a pale background. It lives in greenhouses, conservatories and cellars, hiding by day beneath boards and boxes and in sheltered corners, becoming more active at night. I have seen as many as a hundred individuals of various ages resting within a space of four square feet on the wall of a greenhouse coal-bin, perfectly quiet save for the occasional waving motion of the long antennae. Unlike Roaches, it does not crawl into narrow crevices or beneath boards or boxes lying close to the ground, but requires considerable space to provide for free movement of the long legs and antennae. When disturbed, it makes prodigious leaps, sometimes two or three in succession, alighting with a thump. Though alert, it is easily captured, provided the waving, hair-trigger sensitive antennae are not inadvertently touched, when response is instantaneous. Adults and young may be found at any season of the year, as might be expected under the conditions of its habitat, but mature individuals appear to be more numerous in the autumn. It is very doubtful, however, whether it is able to survive the winter out of doors.

It was first reported from Minneapolis in 1898; I have received it within a few years from Kennebunk, Me., Springfield, and Danvers, Mass., in each case from cellars or greenhouses. It has been recorded also from Rhode Island, Ohio, Illinois, Wisconsin, Kansas, and Canada. Should it become obnoxious

by its presence or its depredations, it could probably be easily controlled or exterminated by poisoned baits made of slices of bread sprinkled with Paris green.

Yellow Cave-cricket.

Ceuthophilus neglectus Scudder.

Plate 14, fig. 20–23.

Ceuthophilus neglectus Scudder, Proc. Amer. Acad. Arts and Sci., vol. 30, p. 67 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 147 (1911).

A small species, recognizable at once by the male genitalia. In this species the ninth dorsal segment is not extended and is usually hidden by the specialized, crescentically thickened, parabolic margin of the eighth; the subgenital plate is also distinctive,—it is short and scoop-shaped with a thickened, semicircular, nearly horizontal margin. The hind femora are short and very stout, convex above and below, armed beneath on the apical two-thirds with a continuous series of short, stout, saw-like teeth; the hind tibiae are curved to correspond with the hind femora and equal or slightly exceed them in length. Ovipositor short, little exceeding the front femora.

General color usually a rich yellow, paler beneath and on the tibiae, overcast above with dark reddish brown; tibial spines pale except at tip.

Measurements.

	Body	Hind femora	Hind tibia	Antenna	Ovipositor
Male	14	12.5	13.5	35–	
Female	15	11.5	11.5	28	7.3 mm.

This is a very common and widely distributed species, occurring generally in woods and in cavities under stones and logs. I have examples from Jackman, Me., Plymouth, Vt., and eastern Massachusetts. Walden records it from Connecticut. It is also widely distributed extralimitally.

The types of this species and *C. terrestris* were almost inextricably mixed by Scudder, but it seems best to recognize this species as characterized above, and *C. terrestris* as elsewhere in this paper. Walker's drawing of the rear view of the male genitalia (Can. Ent., vol. 37, pl. 4, fig. 3b, 1905) is misleading as applied to this species.

Spotted Cave-cricket.

Ceuthophilus maculatus (Harris).

Fig. 60; Plate 14, figs. 24, 25.

Rhaphidophora maculata Harris (Say MS.), Treatise Ins. Inj. Veget., p. 126 (1841).

Phalangopsis maculata Harris, Treatise, 3d ed., p. 156 (1862).

Ceuthophilus maculatus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 434 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 359 (1873).—Fernald, Orth. N. E., p. 19 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 145 (1911).

This species is recognizable at once by the basal curvature of the hind tibiae of the male, and the peculiar, angularly excised border of the ninth dorsal segment of the abdomen. The hind thighs are stout, convex above and beneath, the distal two-thirds of the ventral edge armed with 10 to 20 stout, irregularly disposed and uneven spines. Hind tibiae of male strongly arcuate on basal third, straight or faintly curved beyond, slightly longer than the thighs. Subgenital plate truncate, divided by a median fissure, each half with a sinuate terminal border, forming a bracket-shaped (⌒) hind margin. Ground color pale dull yellow; above chestnut, irregularly mottled with yellow; tibiae and spines pale.

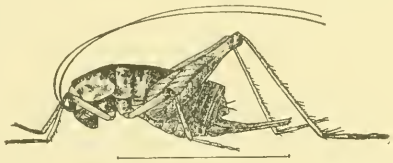


Fig. 60.—Spotted Cave-cricket, *Ceuthophilus maculatus*. Female. (After Lugger.)

Measurements.

	Body	Hind femora	Hind tibia	Antenna	Ovipositor
Male.....	19	16	17.5	45	
Female.....	18	17	18	30+	10.5–11.5 mm.

This seems to be our most generally distributed Cave-cricket, and is of common occurrence in cellars as well as out-of-doors beneath logs, stones, and loose bark of fallen trees and stumps. Though commonly met with in groups of two to five, colonies numbering a dozen or two are occasionally found. Nymphs are most common in early summer but may be found at almost any season; adults are most numerous in August and September,

but often live over winter in cellars, and possibly in sheltered places out-of-doors.

It is found apparently throughout New England and has been recorded from as far west as Colorado.

Woodland Cave-cricket.

Ceuthophilus terrestris Scudder.

Plate 14, figs. 26, 27.

Ceuthophilus terrestris Scudder, Proc. Amer. Acad. Arts and Sci., vol. 30, p. 46 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 144 (1911).

Small to medium in size, the body and legs rather uniform dusky brown above, luteous beneath. Hind femora slender, four times as long as wide, armed beneath on the apical half with a continuous series of small, saw-like teeth, 25 to 30 in number. Hind tibiae straight, longer than hind femora, sometimes luteous, usually dusky except the spines and small areas at the bases of the spines. Hind margin of ninth dorsal segment resembling somewhat in outline, though more broadly rounded, that of the eighth segment of *C. neglectus* (whence a likelihood of confusion) but not conspicuously thickened. Subgenital plate feebly chitinized, often shriveling to such an extent as to be difficult of study, in rear view usually with a median suture and tapering upward into two small outwardly curling processes; the basal portion sometimes appears of firmer texture and joined to the soft apical lobes by a broadly V-shaped union.

Measurements.

	Body	Hind femora	Hind tibia	Antenna	Ovipositor
Male	11–14	11.5–14	13–16	35–40	
Female	11–12	11.5	13	38	6 mm.

This is a slender, dark-colored, soft-bodied species which inhabits cool moist woodlands. It is common in Vermont,—I have examples from Ascutney Mt., Grand Isle, Plymouth, and Woodstock,—and it probably occurs throughout at least the cooler, more heavily forested regions of New England.

Short-legged Cave-cricket.

Ceuthophilus brevipes Scudder.

Plate 14, figs. 31, 32.

Ceuthophilus brevipes Scudder, Boston Journ. Nat. Hist., vol. 7, p. 434 (1862).—Fernald, Orth. N. E., p. 19 (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 145 (1911).

A robust, dull-brown species, mottled with dull yellowish. Hind femora short, armed beneath with from 7 to 25 small appressed saw-like teeth on apical half. Hind tibiae straight, slightly longer than the femora. Ovipositor slender.

Measurements.

	Body	Hind femora	Hind tibia	Ovipositor
Male	14	11	12	
Female	15.5	13	13.5	8.4 mm.

This species was originally described from Grand Manan Id., New Brunswick, and it has since been reported by Blatchley from North Madison, Ct., and Vigo County, Ind., beneath stones. I have never met with the insect in the field.

Black-sided Cave-cricket.

Ceuthophilus latens Scudder.

Ceuthophilus latens Scudder, Boston Journ. Nat. Hist., vol. 7, p. 437 (1862). —Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 146 (1911).

Ninth dorsal abdominal segment only moderately extended, a little flaring, the hind margin sometimes appearing slightly emarginate. Subgenital plate obtuse-angulate emarginate from rear, convex or nearly rectangular from side. Hind femora stout, convex above and below, often unarmed in female, usually with a few tiny denticulations on the apical half, more prominent on the inner edge; hind tibiae straight. Hind thighs brown, punctate with pale; front and middle legs and hind tibiae pale, the large spines on the latter blackish at base.

In color this is our most striking species. The dorsum is black, with the top of head and a narrow mid-dorsal stripe on the thorax, breaking up on the abdomen, chestnut. Eyes dark; face, cheeks, and sides of the thoracic segments white, the lower thickened margins of the latter chestnut.

Measurements.

	Body	Hind femora	Hind tibia	Ovipositor
Male	14	15	16	
Female	16	14.7	15.5	10.5 mm.

Walden has captured this species at Lyme, Ct., under stones, August 5 to 21.

Pale-footed Cave-cricket.

Ceuthophilus lapidicola (Burmeister).

Fig. 61; Plate 14, fig. 28–30.

Phalangopsis lapidicola Burmeister, Hanb. d. Ent., vol. 2, p. 723 (1838).
Ceuthophilus pallidipes E. M. Walker, Can. Ent., vol. 37, p. 115 (1905).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 146 (1911).

Related to *C. latens* but superficially unlike. New England examples before me are chiefly very dull and uniform brown, the dark latero-dorsal stripes so conspicuous in *C. latens* usually lacking, present but not strongly developed in one example.

This is a small and moderately slender species, the hind thighs three and a half times as long as wide, a little convex beneath, and armed with a very variable, irregular series of usually widely set, short, appressed teeth, smaller on the inner edge and in the female castaneous, often with few or no markings. Hind tibiae slightly exceeding the femora, pale, spines dusky at base and tip. Ninth dorsal segment distinctly prolonged backward, truncate-convex. Subgenital plate of male V-emarginate from the rear, rounded from the side.

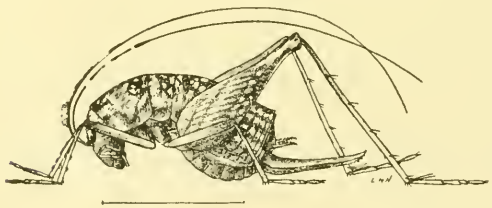


Fig. 61.—Pale-footed Cave-cricket, *Ceuthophilus lapidicola*. Female. (After Lugger.)

Measurements.

	Body	Hind femora	Hind tibia	Antenna	Ovipositor
Male	12–14	13–14	14 –14.8	35	
Female	13–14	13–13.5	13.5–14.8	30	9 mm.

Walden reports this species from New Haven, Ct., and I have taken it at Wellesley in October. It is not a common species in the vicinity of Boston. Walker, who described it under the name

of *pallidipes* from Ontario, finds it plentiful there. Rehn and Hebard have recently synonymized it with *C. lapidicola* of the southern States.

Slender-legged Cave-cricket.

Ceuthophilus gracilipes (Haldeman).

Phalangopsis gracilipes Haldeman, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 346 (1850).

Ceuthophilus gracilipes Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 143 (1911).

A very large and variable species with extremely long antennae and hind legs. The hind thighs are armed beneath with an irregular series of from 8 to 18 long, stout, widely spaced spines, erect in male, shorter and appressed in female, sometimes tumid at base, sometimes bent backward at the half. Hind tibiae exceeding the femora, straight, but sometimes arched basally in the male. Ninth abdominal dorsum prolonged backward its full width, truncate, the corners round. Subgenital plate deeply but nearly rectangularly emarginate.

General color pale yellow, more or less heavily marked above, especially on the hinder portion of the segments, with dark chocolate brown. Legs pale, hind thighs often bearing externally a network of oblique brown markings (scalariform pattern).

Measurements.

	Body	Hind femora	Hind tibia	Antenna	Ovipositor
Male.....	23.5	23	24	75	
Female.....	16–23	22	24	62	13.5 mm.

This large and striking Cave-cricket is recorded by Walden from Mt. Carmel and New Canaan, Ct., in dark, damp cellars, under the bark of fallen trees, and in similar places, from August 6 to September 15. Half-grown young have been taken in a cave at New Ashford, Mass., December 22, by Dr. G. M. Allen. It is a southern species, extending as far as Alabama. It is recorded that over 200 were found in one hollow tree in North Carolina when it was felled.

C. stygius Scudder is stated by Caudell to be a synonym of this species. A single male of this form, taken at Beverly, Mass., in August, is in the collection of the Boston Society of Natural History.

THE CRICKETS—Family GRYLLIDAE.

"What is any man's discourse to me if I am not sensible of something in it as steady and cheery as the creak of crickets?"—THOREAU.

The Gryllidae or Crickets agree with the Tettigoniidae or Locustarians in possessing long, delicately tapering antennae, auditory organs on the front tibiae, and stridulatory apparatus on the wing-covers of the male. They differ in having typically but three joints in the tarsi, an awl-like or needle-like ovipositor, and wing-covers flat above and bent sharply downward at the sides of the body.

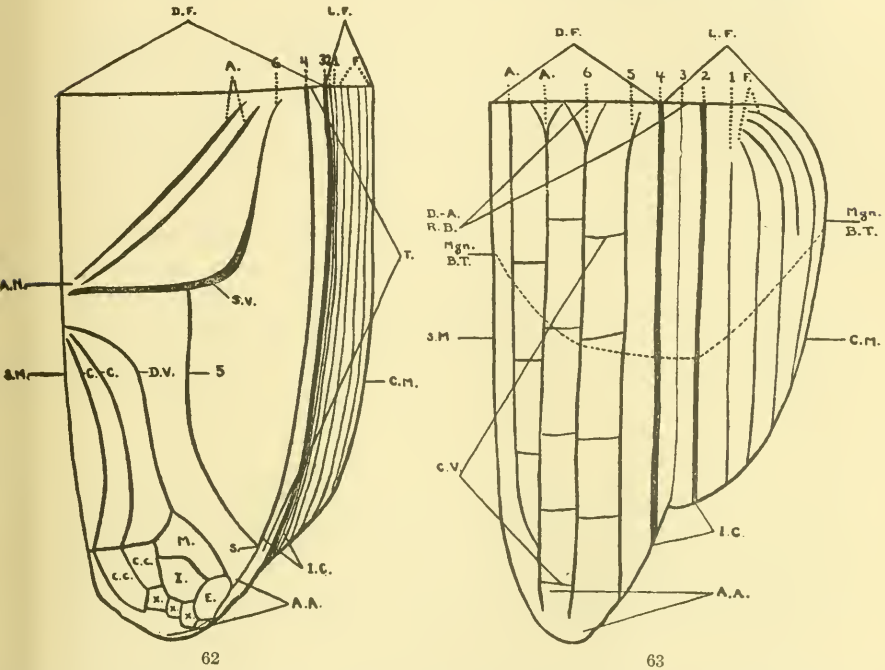
Like the Long-horned Grasshoppers and Katydids, to which they are more closely related than to the Locusts, these are essentially nocturnal insects, but are also active to a considerable extent by day. Three chief groups may be distinguished according to habits: terrestrial, ground, or Field-crickets; arboreal, climbing, or Tree-crickets; and burrowing or Mole-crickets. About twenty species inhabit New England, of which two or three are adventive. Some are among the commonest insects we have, widely distributed, almost ubiquitous; others are scarce and very local, inhabiting areas of special character and limited size.

Crickets are less strictly vegetarian than Locusts, freely eating animal substances, especially other insects; the Tree-crickets particularly feed largely upon aphids. Only about four of our species are sufficiently abundant and obnoxious in habits to be regarded as economically injurious, namely: the large Field-cricket (*Gryllus assimilis*), the smaller Striped Grass-cricket (*Nemobius fasciatus*), the Snowy and the Dusky Tree-crickets (*Oecanthus niveus* and *Oe. nigricornis*).

In their life history, Crickets agree with the majority of the Orthoptera in hatching from the egg early in the season, developing to maturity during the summer, pairing, depositing eggs and dying in the autumn. Exceptions are found in occasional hibernating nymphs of *Gryllus;* and probably also in the Mole-crickets, which are believed to live more than one year.

The eggs of the Field-crickets, so far as observed, are thrust into the soil by means of the slender, awl-like ovipositor; those

of Tree-crickets are placed in the bark or pithy stems of the plants among which they live, in holes drilled with much labor by the



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FIGS. 62, 63.—Diagrammatic sketches of venation of male (Fig. 62) and female (Fig. 63) tegmina of *Nemobius*.

1.—Mediastine vein (Saussure and Brunner).
2.—Humeral vein (Saussure) = Anterior radial vein (Brunner).
3.—Discoidal vein (Saussure) = Posterior radial vein (Brunner).
4.—Median vein = False discoidal vein (Saussure) = Ramus of Posterior radial vein (Brunner).
5.—Ulnar vein = Oblique vein (Saussure) = Anterior ulnar vein (Brunner).
6.—Anal vein (Saussure) = Posterior ulnar vein (Brunner).
A.—Axillary veins.
A. A.—Apical or Distal area.
A. N.—Anal node, Musical node, Node.
C.—Cordes or postaxillary veins.
C. C.—Cells formed by cordes.
C. M.—Costal margin.
C. V.—Cross-veinlets.
D.-A. R. B.—Discoido-anal root-basin.
D. F.—Dorsal field (which includes Apical area).
D. V.—Diagonal vein.
E.—Exterior cell of speculum.
F.—Free veins of Lateral field.
I.—Interior cell of speculum.
I. C.—Intermediate channel.
L. F.—Lateral field.
M.—Speculum or mirror.
Mgn. B. T.—Approximate margin of tegmina in brachypterous forms.
S.—Stigma.
S. M.—Sutural margin.
S. V.—Stridulating veins.
T.—Tambourine.
X.—Cells of apical area.

(From Hebard, Proc. Acad. Nat. Sci. Phila., June, 1913.)

female, whose ovipositor is relatively short, stiff, and toothed at tip; and those of Mole-crickets are laid in underground chambers excavated by the female.

The feature of most popular interest connected with the family is undoubtedly the sounds which they produce by stridulation. Allusions to these so-called 'songs' are constantly appearing in literature. They are, of course, instrumental instead of vocal in character, but serve the same purpose of communication and expression of the emotions as true songs. The study of these is not a whit less interesting than the study of bird music and references are frequently made to them in the succeeding pages.

In some species the songs take the form of a series of chirps or beats, increasing with the temperature from about 40 to 160 per minute, and so regularly that it is possible to compute the approximate height of the mercury by this means. For this purpose the formula

$$T = 50 + \frac{N - 40}{4}$$

has been used for a species of Tree-cricket (*Oecanthus niveus*). In this formula, 50 = the temperature in degrees Fahrenheit at which activity begins to be regular, N = the number of chirps per minute, 40 = number of chirps per minute at 50°, 4 = rate of increase for each degree of temperature, and T = the temperature.

Hebard's Revision of *Nemobius* gives diagrammatic figures illustrating the terminology of the cells and veins of the tegmina, which will serve for *Gryllus* also. Fulton's "Tree-crickets of New York" is the best work on that group. The other references cited below present the latest results of taxonomic study or contain particularly helpful notes, figures, or bibliography.

Gryllotalpa: Rehn and Hebard, "Studies in the Dermaptera and Orthoptera of the coastal plain and Piedmont region of the southeastern United States." Proc. Acad. Nat. Sci. Phila., April 1916, p. 277.

Gryllus: Rehn and Hebard, "The genus Gryllus as found in America." Proc. Acad. Nat. Sci. Phila., May 1915, p. 293–322, pl. 4.—Lutz, F. E., "The variation and correlations of certain taxonomic characters of Gryllus." Carnegie Inst. of Wash., publ. no. 101.

Nemobius: Hebard, M., "Revision of the species of the Genus *Nemobius* found in North America north of the Isthmus of Panama." Proc. Acad. Nat. Sci. Phila., June 1913, p. 394–492.

Neoxabea. See next item.

Oecanthus: Fulton, B. B., "The Tree-crickets of New York: life-history and bionomics." Tech. Bull. N. Y. Agric. Exp. Sta., no. 42, 47 pp. (1915). "Tree-crickets injurious to orchard and garden fruits." Bull. N. Y. Agric. Exp. Sta., no. 388, p. 415–461 (1914).—"Tree-crickets as carriers of *Leptosphaeria conothyrium* and other fungi." Tech. Bull. N. Y. Agric. Exp. Sta., no. 50, 22 pp. (1916).

Tridactylus: Morse, A. P., "Variation in Tridactylus." Psyche, vol. 9, p. 97–199 (1901).—Rehn and Hebard, "Studies in the Dermaptera and Orthoptera of the coastal plain and Piedmont region of the southeastern United States." Proc. Acad. Nat. Sci. Phila., April 1916, p. 283.

Key to Subfamilies of New England Gryllidae.

A. Fore tibiae slender, not fitted for digging. Female with conspicuous external ovipositor.
  B. Second tarsal joint minute, compressed.
    C. Hind tibiae rather stout, armed with stout, movable spines without spinules or serrations between them.
      Field-crickets, Gryllinae, p. 387.
    CC. Hind tibiae slender, with delicate spines and short spinules or serrations between them, or else entirely unarmed.
      Tree-crickets, Oecanthinae, p. 401.
  BB. Second tarsal joint depressed, heart-shaped.
    D. Hind tibiae bearing two rows of spines, without spinules.
      Trigonidiinae, p. 414.
    DD. Hind tibiae with two rows of spines and numerous spinules between them. . . . . Eneopterinae, p. 415.
AA. Fore tibiae enlarged, fitted for digging. Female without exposed ovipositor.
  E. Large species, over 25 mm. long. Two large ocelli present; hind femora but little enlarged; tarsi three-jointed.
    Mole-crickets, Gryllotalpinae, p. 416.
  EE. Small species, less than 10 mm. long. Three small ocelli; hind femora greatly enlarged; tarsi one-jointed.
    Pygmy Mole-crickets, Tridactylinae, p. 416.

THE FIELD-CRICKETS—GRYLLINAE.

It is with these creatures that the name "Cricket" is most commonly associated in the popular mind: black, dark brown, or gray insects of medium size, hopping nimbly away from our approaching footsteps in field and roadside, hiding beneath whatever shelter offers a refuge, and keeping up an incessant din of chirping throughout the warm days and nights of late summer and autumn. The black, soft, stout, depressed body, globose head, ring-shaped pronotum, and spiny, scrambling legs which char-

acterize them are as familiar to everyone as the aspect of their burrowing and climbing cousins is strange. Existing in countless numbers in the fields and pastures, living close to the ground, upon and in it in fact, they must be reckoned, by reason of their abundance and ubiquity in temperate and torrid climes, as one of the dominant forms of insect life.

Key to New England Species of Gryllinae.

(Plate 16.)

A. Large species with body one-half to three-fourths of an inch long. First joint of hind tarsi flat above, with a row of short, stout spines on each side (*Gryllus*).

B. Head black; ground-color black, tegmina and base of hind femora often paler. . . . . Common Field-cricket, *Gryllus assimilis*, p. 389.

BB. Head with a narrow transverse black bar from eye to eye, bordered above and below by a yellow bar. Ground-color yellowish, marked with black. . . . . European House-cricket, *G. domesticus*, p. 391.

AA. Small or medium-sized species. First joint of hind tarsi not spinose above but rounded and hairy (*Nemobius*).

C. Hind tibiae with the ventral pair of apical spurs unequal in length.

D. Size medium to large for this genus. Ovipositor equal to or longer than hind thighs and nearly straight.

E. Ovipositor relatively short, equal to or slightly longer than hind thighs. Tegmina of female short, about one-fourth longer than pronotum, usually spotted with fuscous. Eyes usually nearly *surrounded with yellowish* on cranium. Occiput spotted, *not longitudinally striped.* Size medium.

Spotted Cricket, *Nemobius maculatus*, p. 396.

EE. Ovipositor relatively long, distinctly longer than hind thighs. Tegmina one and a half to one and three-quarters times as long as the pronotum (still longer in long-winged examples).

F. Size medium. Rather slender. Face below antennae black. Dorsal surface of head, pronotum, abdomen, and hind thighs with gray pile, interspersed with black bristles. Tegmina gray above, usually with a fuscous stripe along anal vein in female.

Sand Cricket, *N. griseus*, p. 395.

FF. Size larger. More robust. Varying greatly in size, color, and markings but without the distinctive combinations of characters of the two preceding species.

Common Grass-cricket or Striped Cricket, *N. fasciatus*, p. 393.

DD. Size very small. Ovipositor shorter than hind thighs, upcurved.

G. Coloration nearly or quite solid brown or black, without distinct markings. Abdomen usually wholly dark brown beneath.

Sphagnum Cricket, *N. palustris*, p. 398.

GG. Abdomen yellowish beneath, especially at base; exposed portion above (in short-winged females) mottled with yellowish, usually the pronotum also. Tegmina of female with pale transverse markings on cross-veins of dorsal field and a longitudinal pale streak along its outer margin; tegmina of male usually somewhat varied in tint and with pale line at outer margin of dorsal field. Often long-winged.....Cuban Cricket, *N. cubensis*, p. 397.

CC. Hind tibiae with the ventral pair of apical spurs of equal length. Size medium. Ovipositor short, up-curved.
Carolina Cricket, *N. carolinus*, p. 400.

Common Field-cricket.

Gryllus assimilis (Fabricius).

Fig. 64.

Acheta assimilis Fabricius, Syst. Ent., p. 280 (1775).
Gryllus abbreviatus Smith, Rept. Ct. Bd. Agric. for 1872, p. 354 (1873).—Fernald, Orth. N. E., p. 15 (1888).—Scudder, Psyche, vol. 9, p. 104 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 154 (1911).
Gryllus luctuosus Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868); Rept. Ct. Bd. Agric. for 1872, p. 354 (1873).—Fernald, Orth. N. E., p. 15 (1888).—Scudder, Psyche, vol. 9, p. 104 (1900).
Gryllus neglectus Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868).—Scudder, Psyche, vol. 9, p. 104 (1900).
Gryllus pennsylvanicus Scudder, Psyche, vol. 9, p. 104 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 154 (1911).
Gryllus assimilis Hebard, Proc. Acad. Nat. Sci. Phila., May 1915, p. 295.

Color: black, shining, usually with at least the inner side of the base of the hind femora yellowish brown; tegmina often pale brown and the larger part of the legs yellowish brown, more or less suffused with blackish.

Measurements.

	Body	Pronotum		Tegmina	Wings pass tegmina (macrop.)
		Wide	Long		
Male....	13–21.5	4–5.6	2.5–4	7–11	4–7
Female..	12–21.5	4.5–6	2.5–3.5	5–12.5	6–9

	Hind femora	Antenna	Ovipositor
Male.....	8 –12.5	18–32	
Female.....	8.5–13.5	12–32	9–22 mm.

These measurements are based on about 400 New England examples, of which 27 are long-winged.

The Common Cricket of our fields and roadsides is almost too well known to need description. It is a robust, active, black insect two-thirds to three-quarters of an inch long, abundant in limited areas throughout most of the country in open lands, particularly those that are moist but well drained. Both by sight and sound it is known to nearly everyone.

The Field-cricket varies so much in size, proportions, wing-length, and color that it is not at all surprising that numerous so-called species should have been described, based on these variations. At one time systematic value was placed on wing-length, at another on proportionate length of ovipositor, breadth of head, pronotum, etc. Recent critical studies, however, indicate that, aside from the introduced European House-cricket, only one valid species of the genus is found in America from Canada to Patagonia. While several well-marked races are recognizable, the distribution of which may or may not be connected with geographic factors, the several variants show complete gradation from one to another. The majority of New England examples fall more or less readily into two series according to length of ovipositor: the first of these, with the ovipositor considerably exceeding in length the hind femora, and often with brown tegmina, has commonly been called *abbreviatus;* the other, with proportionally shorter ovipositor, often smaller in size and more generally black in color, has been called *pennsylvanicus* and *neglectus.* Both forms are occasionally long-winged. Females with ovipositor of intermediate length are frequently found, however, and many males cannot possibly be referred definitely to either series. In general, Field-crickets inhabiting cold, dark, and wet places and from the North are smaller and blacker; and those from open sunny areas on loose sandy soil are larger, with pale tegmina and longer ovipositor.

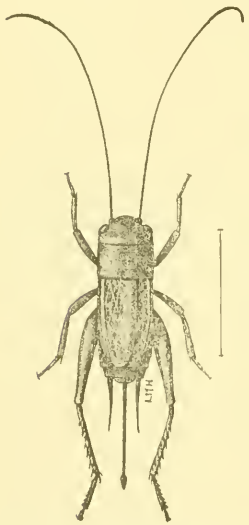


Fig. 64.—Common Field-cricket, *Gryllus assimilis.* Female. (After Lugger.)

Adult Field-crickets begin to appear about the first of June in

southern New England but are not seen in any numbers until the middle of August, continuing in abundance until killed by heavy frosts. The early adults are probably developed from exceptional nymphs which have hibernated in that stage under logs, stones, and in similar shelter. They probably oviposit early and provide a new generation of over-wintering nymphs.

Early in the season, Field-crickets "live singly or in pairs in burrows which they dig for themselves. These are used as retreat during the day-time and serve as shelter from ordinary inclemencies of weather. These burrows are generally forsaken about midsummer for some sort of above-ground shelter. From this time on, until fall, they appear to be more social and live in colonies under various sorts of rubbish. Grain shocks are a favorite haunt for them, and since twine has been used for binding, the crickets have been quite troublesome by cutting the bands" (Bruner). In late summer and fall the females may often be seen while engaged in egg-laying, with the ovipositor driven nearly perpendicularly into the soil.

The Field-cricket inhabits the whole of New England. It is an omnivorous feeder, eating almost any substance, animal or vegetable, that comes to hand out-of-doors,—herbage, fruits, vegetables, dead insects,—and is even cannibalistic when confined with its own kind. Occasionally it attacks garments spread upon the ground, in spite of apparently more toothsome viands near at hand. When it gains entrance to the house, as it often does in the autumn season, it may do injury by eating holes in clothing, carpets, or curtains.

Its loud, chirping call is known to nearly everyone. This is made up of a series of chirps of about a half-second duration, and is often continued for long periods of time in the autumn, both by day and by night.

European House-cricket.

Gryllus domesticus Linné.

Fig. 65.

Gryllus (*Acheta*) *domesticus* Linné, Syst. Nat., ed. 10, vol. 1, p. 428 (1758).
Gryllus domesticus Smith, Rept. Ct. Bd. Agric. for 1872, p. 354 (1873).—Scudder, Psyche, vol. 9, p. 104 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 154 (1911).

Both short-winged and long-winged examples are known in this species; in the former the wings are covered by the tegmina, in the latter they are exposed for nearly half an inch.

Color: pale yellowish brown, marked with brownish and blackish on the head, pronotum, and tegmina. Eyes dark brown; blackish bars across occiput, between eyes, between bases of antennae, and along upper part of lateral lobes of pronotum; top of pronotum mostly dark brown, with yellowish on front margin and sides.

Measurements.

	Body	Pronotum		Tegmina	Hind femora	Ovipositor
		Wide	Long			
Male.....	17	5	3	11	10	
Female.....	16	4.5	3	10	11	11 mm.

The European House-cricket, the "Cricket on the hearth," is a less robust species than our Field-cricket and is readily distinguished by its yellowish color and characteristic markings. It has been introduced into several of the southern and central States, has been taken in New York not far from the Connecticut line, and has recently been recorded in numbers from Shelton, Ct. (M. P. Zappe, Bull. 211, Ct. Agric. Exp. Sta., p. 313–316, 1919), from which the following statements are quoted nearly *verbatim*.

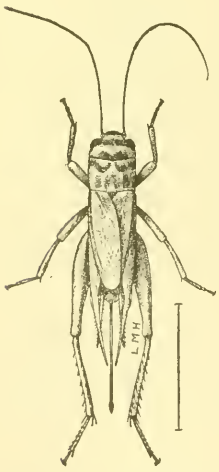


Fig. 65. — European House-cricket, *Gryllus domesticus*. Female. (After Lugger.)

"It was living in the attic of a new house and annoying the occupants [July 29, 1918] by its nightly chirping and by getting into the food in the pantry on the floor below. . . . There were great numbers of crickets in the attic, with considerable old clothing stored there, some of which had been eaten into by the crickets. During the day they were in hiding and comfortably quiet, but at night they chirped incessantly." There were two rooms in the attic, a sleeping room and a store room. A crookneck squash in the storeroom had its entire inside, seeds, pulp and all, eaten out by the Crickets. A great number of them

were hiding between the rafters, roof-boards and shingles. They gnawed into the wood, and the floor was covered with bits of chewed wood.

"At night they came downstairs and got into the pantry where they ate into all sorts of food that they could get at. They seemed to be particularly fond of bananas. A few could be found in the daytime in the drawers in the pantry, in the flour, etc., and were as much of a pest as cockroaches. . . .

"It is hard to understand just where these crickets came from, unless they had been present in the office of a large garage next door, and from there had entered this residence. None of the other houses in the immediate neighborhood had been troubled with this pest."

To destroy them two kinds of poisoned bait were used: (1) potato flour soiled by the Crickets, ½ lb.; borax, ½ lb.; one mashed ripe banana. This was all mixed together and enough water added to make a thin paste. (2) Bichloride of mercury, 1 tablet dissolved in ½ cupful of water; this was added to a cupful of flour. The skin of a banana was cut up into small pieces and put into the bait. Two days later all of the poisoned bait had been eaten, a few Crickets were still alive but succumbed to continued treatment. It is not known which bait was preferred.

This insect usually occurs on the ground floor of houses or bakeries in the vicinity of warmth, sometimes burrowing into the mortar of the walls. It is active and musical, chiefly at night, even in winter.[1]

Striped Grass-cricket.

Nemobius fasciatus (DeGeer).

Plate 16, figs. 3, 4.

Gryllus fasciatus DeGeer, Mém. Hist. Ins., vol. 3, p. 522 (1773).

Acheta vittata Harris, Treatise, 3d ed., p. 153 (1862).

Nemobius exiguus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 429 (1862).

Nemobius vittatus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 430 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1869); Rept. Ct. Bd. Agric. for 1872, p. 353 (1873).

Nemobius fasciatus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 430 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 144 (1868); Rept. Ct.

[1]Several adults and one half-grown nymph were captured in a house at Swampscott, Mass., February 22, 1920.

Bd. Agric. for 1872, p. 354 (1873).—Fernald, Orth. N. E., p. 16 (1888).—Scudder, Psyche, vol. 9, p. 104 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 151 (1911).—Hebard, Proc. Acad. Nat. Sci. Phila., June 1913, p. 405.

The largest of our species of Nemobius, varying much in size, color, and markings. Tegmina rather long, covering about three-fourths of the abdomen in the male, two-thirds in the female. In the form with fully developed wings, the tegmina are somewhat longer than in the short-winged examples, and the wings are more than twice the length of the tegmina. Ovipositor considerably longer than the hind femora, straight or with a very feeble upward curve, the apex of the upper valves armed with relatively few, graduated, widely spaced and (when unworn) acutely pointed teeth.

Color: usually rusty brown, varying to grayish, or even almost solid black with brownish tints on the feet and hind femora, marked especially on pronotum and abdomen with blackish. A black lateral stripe is usually evident on the sides of pronotum, tegmina, and abdomen. Three longitudinal black stripes are often present on the occiput. The tegmina may be unmarked, spotted, or streaked above, and vary from black to pale brown or gray. The palpi vary from black to pale brown with the last joint tipped with blackish. The bristles of the body are black and the color of the short pile covering the body varies much, but generally agrees with that of the part of the body it covers.

Measurements.

	Total	Hind femora	Tegmina	Ovipositor
Male	6.5–9.5	4.5–6.6	3.5–5.5	
Female	8 –12	5 –7	2.5–5.5	6–8.8

Macropterous examples

	Total	Tegmina
Male	11 –16.5	4–6
Female	14.5–18.5	5–7.5 mm.

This Cricket, while usually found with short tegmina and aborted wings, is also represented nearly everywhere by individuals with fully developed flight-organs. The long-winged form varies much in abundance in different localities. Occasionally it appears in large numbers in some particular spot, or comes to

lights at night in swarms. In New England it seems to be more plentiful at high elevations, even on mountain tops (Mt. Ascutney, 3300 feet; Mt. Greylock, 3500 feet). In the vicinity of Boston less than ten per cent of examples are long-winged.

This is by far our commonest species of Nemobius and it is plentiful in all parts of New England from extreme northern and eastern Maine to Nantucket and southwestern Connecticut. Extralimitally it occurs from Prince Edward Island to Manitoba, and from Virginia to New Mexico, while another geographic race extends to the Gulf Coast and Mexico City.

Adults begin to appear in early July in Connecticut, and late in July in Maine, and linger until killed by hard frosts. It is nearly ubiquitous, inhabiting a wide variety of situations, and often literally swarms at the edges of meadows and marshes and in the damper, densely grassed spots of pastures and fields. If a census were taken of our New England Orthoptera, this little Cricket would stand near the head in numbers. Though usually not accounted an injurious insect, it is undoubtedly responsible for a very considerable diminution of feed in our New England pastures.

The song is a high-pitched, silvery or tinkling trill, often continuous, sometimes broken irregularly or reduced to a chirp. Its quality and delivery vary widely and are doubtless affected by the size and emotions of the performer, the temperature, and the acoustic and other conditions of the time and place. It also sounds different according to the degree of sensitiveness of the ear of the hearer. At least, this seems the only way to account for the divergent statements of observers, who have attributed to several species songs unquestionably delivered by this one. It has been rendered by various authors as *tiiiii* or *ti-ti-ti-ti-ti*, *creeeee*, or *creee-creee-creee* and *plee-e-e*, *plee-e-eee*.

Sand Cricket.

Nemobius griseus E. M. Walker.

Plate 16, figs. 1, 2.

Nemobius griseus E. M. Walker, Can. Ent., vol. 36, p. 182 (1904).—Hebard, Proc. Acad. Nat. Sci. Phila., p. 434 (1913).

Size medium; rather slender. Grayish above, with blackish sides. Tegmina of male covering abdomen or a little less; of female short, with obliquely rounded apex, gray, with a black line on anal vein. Entire body covered with a very fine, short, grayish pile. Crown of head with three longitudinal black stripes. Face below antennae, sides of pronotum and tegmina, base of abdomen, and often also the antennae, femora, tibiae, and ovipositor black or blackish, otherwise brown. Ovipositor longer than hind femora, nearly straight; its apex short, with a few widely separated prominent teeth.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	5.5–8.6	3.7–4	4.6–5.3	
Female	9 –9.5	2.6–3	6 –6.5	6.5–8 mm.

This slender, grayish-brown Cricket lives only in sandy places, in which its color and pubescence serve a protective purpose. It is likely to be passed by for a somewhat similarly colored form of *N. fasciatus* which is frequently found in sandy areas.

I have taken it in small numbers at Brunswick, Me., Provincetown and South Sudbury, Mass., and Walden has secured it at North Haven, Ct. All specimens were taken in September (2 to 23) but Walker, who discovered it, records it from August 3 to September 15 in Ontario. It is known also from Indiana, and in a southern race from Georgia.

Little Spotted Ground-cricket.

Nemobius maculatus Blatchley.

Plate 16, fig. 7.

Nemobius maculatus Blatchley, Psyche, vol. 9, p. 52 (1900); 27th Ann. Rept. Dept. Geol. Nat. Resources Indiana, p. 424 (1903).—Hebard, Proc. Acad. Nat. Sci. Phila., p. 430 (1913).—Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., p. 287 (1916).

A medium-sized species of robust appearance. Tegmina of female but little longer than pronotum, obliquely rounded-truncate at tip; of male covering two-thirds to three-fourths of the abdomen, marked with yellow along the discoidal vein (dorsolateral angle). Long-winged examples are unknown. Ovipositor about as long as hind femora, nearly straight; its apex

short, with straight dorsal margin, armed with sharp, rather widely placed teeth.

In general effect the color is mottled reddish brown, due to dark brown spotting on a buffy ground. The spotted effect is especially noticeable on the tegmina of the female and the hind thighs, less so on top of head and pronotum. The eyes seem especially conspicuous owing to their being nearly surrounded by the yellowish ground color. A broad dark-brown lateral stripe covers most of the sides of the pronotum, deflected area of the tegmina, and base of abdomen.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	8	3.5–4	5	
Female	8.5–9	2.3–2.5	6	5.5–5.7 mm.

The Little Spotted Cricket or Spotted Ground-cricket is said by Blatchley, its discoverer, to live in low, open woods in damp situations beneath logs and in their vicinity. Sometimes colonies of considerable size are found, but otherwise it is likely to escape the notice of the collector, who passes it by for its more abundant relative, *N. fasciatus*. The only New England locality thus far known is New Canaan, Ct., where Walden found it on September 11. Beyond our limits it is known to extend as far as Indiana, Arkansas, and North Carolina.

Cuban Ground-cricket.

Nemobius cubensis Saussure.

Nemobius cubensis Saussure, Miss. Sci. Mex., Rech. Zool., vol. 6, p. 384 (1874).—Hebard, Proc. Acad. Nat. Sci. Phila., p. 455 (1913).

Size small. Tegmina of male covering body except subgenital plate; of female about two-thirds of abdomen, rather squarely truncate. Ovipositor two-thirds to four-fifths as long as hind femora, gently upcurved, the apex very finely and evenly serrate. Long-winged specimens are not uncommon in the South; in these the tegmina are a little prolonged and the wings are twice as long as the tegmina.

Dark brown above; paler beneath, the base of abdomen yellowish. Face and legs medium brown. Top of head (sometimes), top of pronotum (often), and abdomen of female spotted

with yellow. Femora and tibiae brownish yellow mottled with dark brown. Tegmina of female with pale markings on cross veins and a pale longitudinal stripe along outer margin of dorsal field; of male, usually varied in tint and with a pale line along outer margin.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	5–6	3.5–4	3.8–4.5	
Female	6–7	2.5–3.5	4.5–5	3–3.5 mm.

This species is very closely related to *N. palustris* of Blatchley, and it is not impossible that the two should be regarded as forms of one species. Both structural and color differences are very slight and the two may intergrade.

Several New England specimens which I refer to this species were captured at South Kent and Canaan, Ct., August 18 and 19. They were at one time determined by Scudder as *N. carolinus* and by me as *N. palustris*, but they seem to belong more correctly to *N. cubensis* as defined by Hebard in his recent revision. I have also seen a female from New Haven, Ct., kindly sent me by Walden, which probably belongs to this species. All these specimens are regarded by Hebard as variants of *N. palustris*.

Sphagnum Cricket; Marsh Ground-cricket.

Nemobius palustris Blatchley.

Plate 16, figs. 11, 12.

Nemobius palustris Blatchley, 27th Ann. Rept. Dept. Geol. Nat. Resources Indiana, p. 427 (1903).—Morse, Psyche, vol. 13, p. 158, in part (1906).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 152 (1911).—Hebard, Proc. Acad. Nat. Sci. Phila., p. 468 (1913).

A very small, dark-colored Cricket found in swamps and bogs, closely related to *N. cubensis*, of which it may possibly prove to be a northern race. Tegmina short, of female covering little more than half of abdomen, of male about three-quarters. Long-winged examples have not yet been taken. Ovipositor one-fourth to one-third shorter than hind femora, gently upcurved, the apex very finely serrulate and occupying one-fourth to one-third of its length.

Color: body and tegmina shining black to dark brown, the feet and legs paler, sometimes very slightly mottled, and sometimes with one or two pale spots on inner side of hind femora near hind knees. Abdomen usually dark brown beneath, sometimes paling to buffy brown at base. The nymphs are usually nearly uniform dark brown. Palpi dark brown, the second joint sometimes bone-white.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor	Antenna
Male.....	5.4–6	3.4–3.7	3–3.5		8
Female.....	6 –7	2.7–3.2	3.5–4	2.5–3	8 mm.

This is our smallest Ground-cricket and almost our smallest orthopteran. It is insignificant in size, inconspicuous in color, and retiring in habits. Its human interest is chiefly in its association with a peculiar type of habitat the charm of which lies in the unexpected novelty of virgin wildness and suggestion of the far Northland.

It lives in cold, saturated peat-bogs among sphagnum mosses, sedges, and rushes interspersed with thickets of leather-leaf, sheep-laurel, and rhodora. Here it skips nimbly about or hides away from the intruder in the recesses of the sphagnum. When the frosts have yellowed the tamarack leaves, turned the pitcher-plants and sundews carmine, and made a crimson-tufted carpet of the spongy sphagnum, one may still find them there, shining black or dark-brown midgets, living in a realm of color and mystery known only to those who love the wilderness and seek it out. It is rarely found in more open meadows, grassy, but with a substratum of sphagnum. The colonies are local, often limited to a few square rods in extent. The agile, wide-awake little creatures, even though numerous, are by no means easy to capture; the best method is to place the net on the ground and drive the Crickets upon it.

Their song, like themselves, is tiny; a feeble continuous trilling, sounding faint and far away even though the little creatures are at one's feet.

This little Cricket is not uncommon locally in the vicinity of Boston, where I have taken it at West Andover, Dover, Natick, and Wellesley. On a bog at Orono, Me., I found the young August 5, a few nymphs and numerous adults August 30; in

Massachusetts I have taken adults from September 6 to October 16. Walden records it from Connecticut, and extralimitally it extends to Indiana and North Carolina.

Carolina Ground-cricket.

Nemobius carolinus Scudder.

Plate 16, figs. 5, 6, 9, 10.

Nemobius carolinus Scudder, Proc. Boston Soc. Nat. Hist., vol. 19, p. 36 (1877).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 152 (1911).—Hebard, Proc. Acad. Nat. Sci, Phila., p. 473 (1913).

Size medium for *Nemobius*, rather broad, especially the male. Short-winged, the tegmina covering abdomen in male, two-thirds or three-fourths of it in female. Ovipositor short, upcurved, armed at its tip with relatively few high, distant, erect teeth. Disto-ventral spurs of hind tibia equal in length, a character that at once distinguishes this species from all others inhabiting New England.

Color: hair-brown, dark above, sometimes very pale on legs and beneath, the tegmina and pronotum nearly black in northern specimens. A pale line often extends along edge of tegmina. The coloration is exceptionally uniform and singularly free from spots and stripes.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	5.5–8.8	4–5.5	4.4–6	
Female	6.5–8	3–4	4.5–5.5	2.5–3 mm.

This is a common Cricket locally, next to *N. fasciatus* the most common *Nemobius* in New England, sometimes occurring plentifully in colonies in suitable localities, but not as generally distributed as the latter. It frequents the densely grassed areas in damp pastures, and is often common under dead leaves on the edges of swampy woodlands, and under logs and boards near by. Its song is a continuous, high-pitched trill, of less volume but with a silvery, singing quality more pleasing to the ear than that of *N. fasciatus*.

It is found throughout New England. I have seen it from Jackman in the western part of Maine (Me. Exp. Sta.) and have taken it at Fort Fairfield and Caribou in the northern part of the State

and Grand Lake Stream in the eastern part; at Woodstock, Vt.; and Waltham, Wellesley and vicinity in Massachusetts. Walden records it from points in Connecticut. Dates of capture range from August 15 to November 1.

THE TREE-CRICKETS—OECANTHINAE.

The Tree-crickets differ so widely in appearance from the common notion of a Cricket (which is based on that of the Ground- or Field-crickets) that the novice is likely to pass them by as something else. The difference, however, though great, is less than that shown by the burrowing or Mole-crickets.

Tree-crickets are slender-bodied, delicately formed, slow-moving insects with but feeble leaping powers, and spend their lives wholly above ground among the leaves and branches of trees, shrubs, and weeds. Their eggs are placed in the bark or pithy stems of the plants on which they live, in holes drilled by the ovipositor of the female. The punctures thus made are sometimes sufficiently numerous to be injurious by mechanically weakening the stem or interfering with the circulation of the sap in it, resulting in its death or breaking down, with consequent loss of fruit-crop; or by providing a means of entrance for the spores of fungi or bacterial diseases. The injury done is perhaps often more than compensated by the destruction of aphids and scale insects infesting the plant, upon which the Crickets feed in both adult and immature stages. They also eat other insects and tender plant tissue in leaves, flowers, and fruits.

Perhaps the trilling stridulation of Tree-crickets has attracted the attention of literary minds even more generally than the chirp of the Crickets of the field. Many passages in prose and verse reflect the influence that the songs of these insects have exerted on the aesthetic sensibilities of their hearers. These insects are, in truth, veritable dryads, of fairy-like daintiness and evasiveness, often heard but seldom seen. One of them haunts the pine trees and its voice is a continuous trill, low and silvery, that carries to a surprising distance. It seems to be ventriloquial in effect, and correspondingly difficult to trace to its source.

The song of another—the Snowy Tree-cricket—has received various descriptive appellations. Burroughs calls it a "purring";

Thoreau a "slumbrous breathing" and "intenser dream"; "Hawthorne has given it a more spiritual interpretation than either Burroughs or Thoreau. He describes it as an 'audible stillness,' and declares if 'moonlight could be heard, it would sound like that' " (McNeill).

In producing the call, the tegmina of the male are raised at right angles to the body, exposing a hollow on the metanotum into which a secretion is poured from glands in the body, which is attractive to the female. Drawn by the call she climbs over his

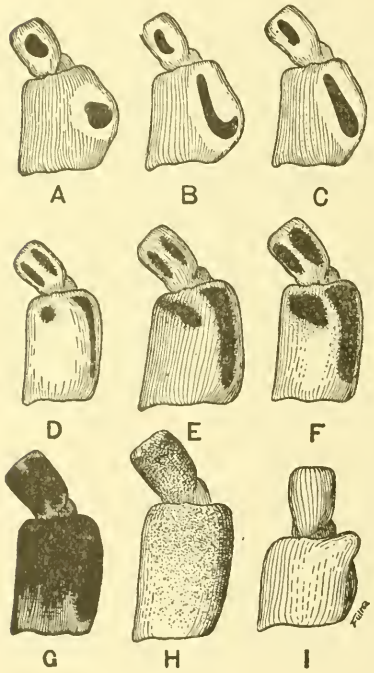


Fig. 66

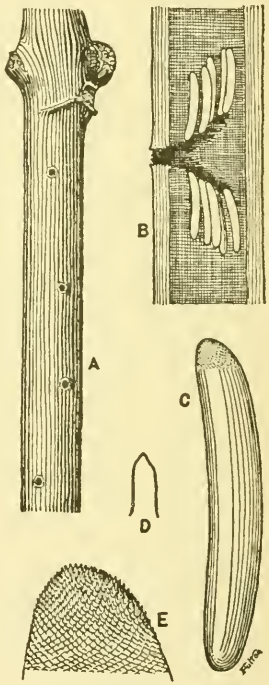


Fig. 67

Fig. 66.—Basal antennal segments of Tree-crickets. *A*, Snowy Tree-cricket, *Oecanthus niveus; B*, Narrow-winged Tree-cricket, *Oe. angustipennis; C*, Davis' Tree-cricket, *Oe. exclamationis; D*, Four-spotted Tree-cricket, *Oe. quadripunctatus;* E, Pine Tree-cricket, *Oe. pini; F*, Dusky Tree-cricket, *Oe. nigricornis*, light form; *G*, same, dark form; *H*, Broad-winged Tree-cricket, *Oe. latipennis; I*, Two-spotted Tree-cricket, *Neoxabea bipunctata.* (After Fulton.)

Fig. 67.—Broad-winged Tree-cricket, *Oecanthus latipennis. A*, egg-punctures in grape (x 1½); *B*, longitudinal section showing eggs in goldenrod (x 3); *C*, egg (x 15); *D*, projection of egg-cap (x 500); *E*, egg-cap (x 50). (After Fulton.)

Note.—The Broad-winged Tree-cricket (*Oecanthus latipennis*) has not yet been recorded from New England, but is found in New York State, and is included here for convenience.

abdomen and feeds upon the alluring substance, giving him an advantageous opportunity to effect mating.

In ovipositing, the female first selects a suitable spot, which differs with the species, and prepares it by chewing a small hole in the bark. This done she inserts the tip of her ovipositor, drills a hole by twists and turns of the abdomen, and enlarges it by repeated insertions and withdrawals of her ovipositor. The egg is then laid, a small amount of mucilaginous fluid discharged into the hole, and the ovipositor withdrawn. She then plugs the mouth of the hole with bits of chewed bark or excrement, carefully packing it in and sealing the opening. The whole procedure requires from fifteen minutes to an hour. In most species a hole is drilled for each egg, but in some cases a pair or even several eggs are inserted through a single opening but in different directions. The eggs are elongate, cylindrical, slightly curved, and one end is ornamented with minute projections arranged like the scales of a pine cone.

Tree-crickets are much more plentiful in southern than in northern New England, and the northern limits of the ranges of our various species are unknown, few observations and specimens being available.

Key to the Species of New England Tree-crickets.

A. Hind tibiae armed with several pairs of weak spines and serrations between them; hind wings but little longer than tegmina.

B. First and second joints of antennae each with but one black spot on underside, that on the first joint situated on a swelling.

C. Both spots more or less circular.

Snowy Tree-cricket, *Oecanthus niveus*, p. 404.

CC. Basal spot greatly elongate.

D. Basal spot J-shaped.

Narrow-winged Tree-cricket, *Oe. angustipennis*, p. 406.

DD. Basal spot straight, club-shaped.

Davis' Tree-cricket, *Oe. exclamationis*, p. 407.

BB. First and second joints of antennae either black or each with two black spots on underside, those on basal joint sometimes connected.

E. Underside of abdomen pale, whitish. Antennal spots rather narrow, distinct, the outer spot on the first joint varying from round to triangular and oblique.

Four-spotted Tree-cricket, *Oe. quadripunctatus*, (see footnote, p. 404).....p. 410.

EE. Underside of abdomen dark.

F. Underside of abdomen black. Antennae, head, and pronotum

often black; if pale, the spots on first joint of antennae broad, often united.....Dusky Tree-cricket, *Oe. nigricornis*,[1] p. 409.

FF. Head, pronotum, and underside of abdomen brown. Outer spot on first joint typically elongate, oblique.
Pine Tree-cricket, *Oe. pini*,[1] p. 412.

AA. Hind tibiae without either spines or serrations; wings nearly as long again as tegmina. First joint of antenna with a blunt tooth on under side.
Two-spotted Tree-cricket, *Neoxabea bipunctata*, p. 413.

Snowy Tree-cricket; White Climbing Cricket.

Oecanthus niveus (DeGeer).

Figs. 66 A, 68; Plate 18, fig. A.

Gryllus niveus DeGeer, Mém. Hist. Ins., vol. 3, p. 522 (1773).

Oecanthus niveus Harris, Treatise, 3d ed., p. 54 in part (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 352 (1873).—Fernald, Orth. N. E., p. 17 in part (1888).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 157 (1911).

Pale greenish white in life, drying in cabinet specimens to pale ivory. Forehead and basal segment of antennae orange yellow. A small round black spot on the under side of the first and second joints of the antennae. Ovipositor brown, tipped with black.

Measurements.

	Total	Tegmina		Hind femora	Antenna	Ovipositor
		Wide	Long			
Male.....	16–18	6–7	12.5–13	8.5–9	28	
Female.....	16–17		11.5–12	9	24	5.5 mm.

The Snowy Tree-cricket is readily recognized by the antennal markings, broad tegmina, and characteristic song of the male. Many of the references in economic literature to this species apply to others either in part or wholly. This Cricket, though common and widespread, is no more abundant or injurious in its habits than some others. It is very secretive, less social, and, living in dense tangles of shrubbery and vines or upon the branches of trees, is less likely to be seen and captured than either the Four-spotted or the Dusky Tree-cricket. On the other hand, from its fondness for the vines and shrubbery about houses, where its song

[1] The antennal markings of these three species apparently intergrade in New England specimens; *Oe. nigricornis* and *Oe. pini* are typically stouter and darker colored than *Oe. quadripunctatus*.

forces itself upon our attention, it is known by reputation more widely than the others.

The song is striking in character, a long-continued series of rhythmic pulsations. It is referred to by Thoreau in the passage "the slumbrous breathing of crickets throughout the night." And it is the more noticeable for the reason that several nearby individuals often chant in unison. (See p. 386.) As might be expected, the synchrony is often not perfect, different groups of

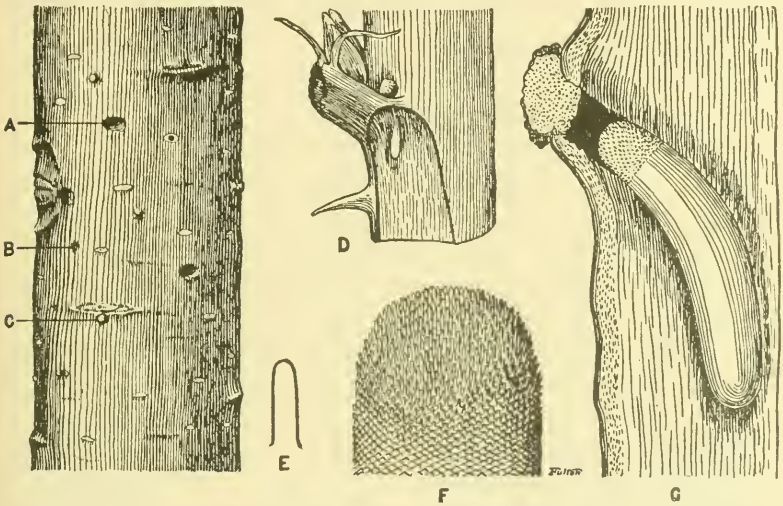


FIG. 68.—Snowy Tree-cricket, *Oecanthus niveus*. *A*, egg-puncture of previous year healed over, in apple bark; *B*, recent egg-puncture without plug; *C*, egg-puncture with plug (all x 1½); *D*, egg in raspberry (x 2½); *E*, projection of egg-cap (x 500); *F*, egg-cap (x 50); *G*, egg in apple bark (x 15). (After Fulton.)

performers varying independently. Nor do the formulas for calculating the temperature (referred to above) give absolutely correct results, but they are sufficiently accurate to make observations on these little musicians interesting to the insect physiologist.

The Snowy Tree-cricket deposits its eggs singly, unlike our other two common forms, the Dusky and the Four-spotted, usually choosing apple, plum, cherry, and elm trees, but also placing them in a large number of other trees and woody vines. It is of economic importance chiefly because of its abundance in neglected orchards, where its punctures scar and injure the twigs and

provide an entrance for canker and blight. In old trees the eggs are placed chiefly in the bark at the bases of fruit-spurs or in that of the larger branches; in small trees that of the trunk also is attacked. The protuberances of the egg-cap are cylindrical, two to three times as long as their diameter, with rounded tip.

This Cricket is common throughout southern New England, and I have seen it from the vicinity of Portland, Me. (Me. Exp. Sta.). How far north and east its range extends is not known, but should not be difficult to determine through the agency of its characteristic song.

Narrow-winged Tree-cricket.

Oecanthus angustipennis Fitch.

Figs. 66 B, 69; Plate 18, fig. C.

Oecanthus angustipennis Fitch, Trans. N. Y. State Agric. Soc., vol. 16, p. 411 (1856).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 158 (1911).

Slender, greenish-white, the male with narrow tegmina. Antennae with but one black mark on under side of each of first two joints, that on the basal joint linear, its proximal portion bent sharply inward; that on the second joint shorter, about

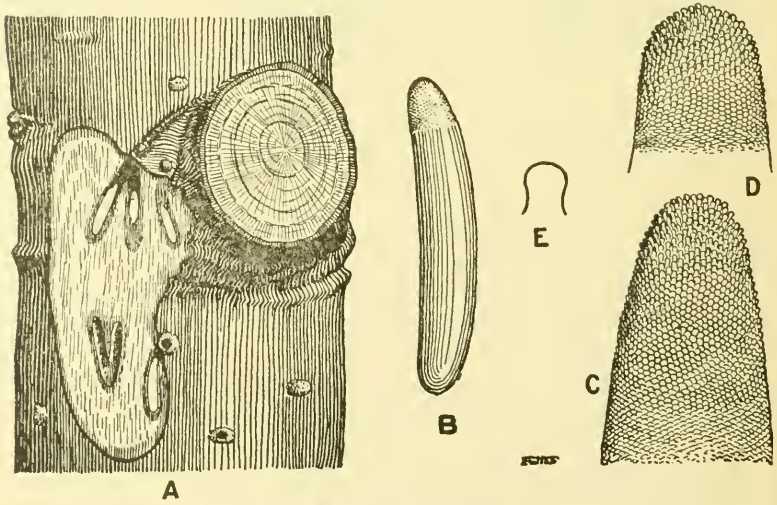


Fig. 69.—Narrow-winged Tree-cricket, *Oecanthus angustipennis*. *A*, Egg-punctures in apple wood (x 3); *B*, egg (x 15); *C*, *D*, long and short egg-caps (x 50); *E*, projection of egg-cap (x 500). (After Fulton.)

twice as long as broad. Fore-head and basal segment of antennae yellow or orange; often a grayish longitudinal streak on the pronotum.

Measurements.

	Total	Tegmina		Hind femora	Antenna
		Wide	Long		
Male.....	15–17	4–5.3	11.4–12.5	8.5	25
Female.....	17–19		12 –14	8.5–9	26–28 mm.

In western New York this is a common insect in apple orchards; on Long Island it frequents the post and scrub oaks. It has also been reported from alder swamps, and in Florida from goldenrods and other low plants by the roadside. In New England it lives in low jungles of sweet-fern as well as on the trunks and branches of forest trees. It has been taken at various points in Connecticut and in the vicinity of Boston, Mass., between August 14 and October 20, but probably might be found earlier.

The eggs are laid in branches one-third to one-half an inch in diameter, in thick, wrinkled places in the bark, often where small twigs fork, several being arranged in an irregular group. Sometimes two eggs, placed at an angle, are inserted through a single opening. The protuberances of the egg-cap are short, scarcely longer than wide, rounded at top and constricted below.

The song is described as intermittent but not rhythmical, each trill continuing for from one to five seconds, usually about two. The number of trills per minute varies from one minute to the next, and usually ranges from ten to fifteen. Occasionally an individual will trill continuously for a minute or more. The song is not so loud as that of the Snowy Tree-cricket; it has a higher pitch and more mournful quality, and is likely to pass unnoticed by anyone not seeking to detect it, particularly when *Oe. niveus* is singing near by. Faxon says that it suggests "the spring notes of the toad heard afar off."

Davis' Tree-cricket.

Oecanthus exclamationis Davis.

Figs. 66 C, 70; Plate 18, fig. B.

Oecanthus exclamationis Davis, Can. Ent., vol. 39, p. 173 (1907).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 158 (1911).

Nearly related to *Oe. angustipennis* but a little larger. General color very pale greenish white, the pronotum not clouded. The

two black marks on proximal joints of antennae form an inverted exclamation-point, being nearly in line and the longer one straight and somewhat club-shaped. The spines on the hind tibiae are smaller than in any other of our New England species.

Measurements.

	Total	Tegmina		Hind femora	Antenna
		Wide	Long		
Male.....	20	4.5	13	8	28
Female.....	21	3	13	10	27 mm.

This Cricket is common on Long Island and Staten Island, New York, and in New Jersey, where it was first discovered by Mr. Wm. T. Davis, a close student of the songs of our musical insects,—cicadas and saltatorial Orthoptera,—whose attention was arrested by the character of its song.

Walden records taking this Cricket on the trunks of trees near New Haven, Ct., from August 20 to October. It is common on post oak on Long Island. In captivity the females deposited most of their eggs in the thick bark of red-oak branches half an inch or more in diameter at the base of side shoots. The protuberances of the egg-cap are mere low, rounded elevations looking like scales.

The song is described as resembling that of *Oe. angustipennis*, being intermittent, non-rhythmical, and low in pitch, the length of note and rest being about two seconds but varying much. The sound begins weakly, increases in volume and slightly in pitch, continues uniformly and ends abruptly. "In quality

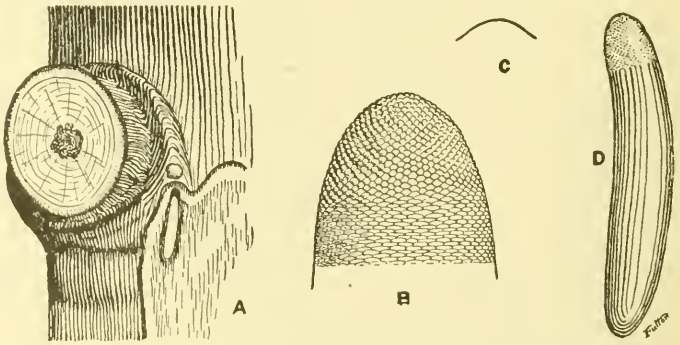


FIG. 70.—Davis' Tree-cricket, *Oecanthus exclamationis*. *A*, egg in oak (x 3); *B*, egg-cap (x 50); *C*, projection of egg-cap (x 500); *D*, egg (x 15). (After Fulton.)

it most resembles the distant singing of the common toad" (Fulton).

Dusky Tree-cricket.

Oecanthus nigricornis Walker.

Figs. 66 F, G, 71; Plate 17, fig. C.

Oecanthus nigricornis Walker, Cat. Derm. Salt. Brit. Mus., vol. 1, p. 93 (1869).—Scudder, Psyche, vol. 9, p. 119 (1900).

Oecanthus fasciatus Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 159 (1911).

Very variable in amount of black in coloration, ranging from almost completely black body and antennae with transparent dusky greenish tegmina and wings, to a generally pale green coloration with dusky antennae, eyes, tibiae, and tarsi. The abdomen is always blackish beneath, and there are often three more or less distinct longitudinal stripes on the middle and sides of the pronotum. The black antennal markings may be lost in the general blackish suffusion, or may vary to the form of those characteristic of *Oe. quadripunctatus;* on the first joint the outer mark is often elongate triangular, prolonged obliquely outward, and often united broadly to the inner mark; on the second joint the marks are broad and nearly or quite united.

Measurements.

	Total	Tegmina		Hind femora	Antenna	Ovipositor
		Wide	Long			
Male.....	13–18	4.5–5.5	10–11	8–9	24–31	
Female.....	15–18		11–12.5	8–9	22–28	5 mm.

This Tree-cricket is closely related to *Oe. quadripunctatus*, differing mainly in coloring and in being more robust. The pronotum averages broader, particularly on the front margin. It frequents raspberry and blackberry canes and sometimes injures them severely in ovipositing. The eggs are placed close together in long rows with the result of weakening or killing the ends of the canes and thereby reducing the crop of fruit. Other plants in which it oviposits commonly are goldenrod, horseweed, and the twigs of willow, elder, maple, elm, sumac, grape, peach, and probably many others. The protuberances of the egg-cap are cylindrical, with rounded, not enlarged, tip, and only about one and one-half times as long as the diameter of the base.

The song is a continous trill, much like that of the Four-spotted Tree-cricket, a little higher in pitch, and often seems to possess more volume and intensity. It is frequently given in the afternoon as well as at night.

The distribution of this Tree-cricket coincides with that of the Four-spotted. It has been taken at Brunswick and Hoxie, Me.; Franconia, N. H.; Woodstock, Vt.; and at many points in southern New England.

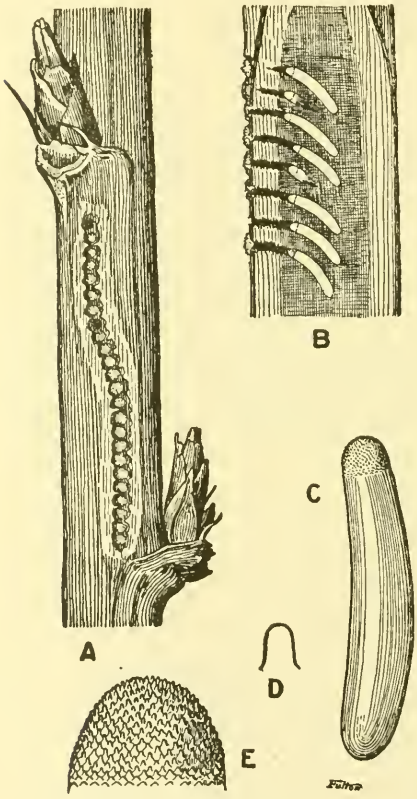


Fig. 71.—Dusky Tree-cricket, *Oecanthus nigricornis*. *A*, egg-punctures in raspberry (x 1½); *B*, longitudinal section of the same (x 3); *C*, egg (x 15); *D*, projection of egg-cap (x 500); *E*, egg-cap (x 50). (After Fulton.)

Four-spotted Tree-cricket.

Oecanthus quadripunctatus Beutenmüller.

Figs. 66 D, 72; Plate 18, fig. D.

Oecanthus quadripunctatus Beutenmüller, Bull. Amer. Mus. Nat. Hist., vol. 6, p. 271 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 159 (1911).

Pale greenish white, becoming yellowish when dried. First and second antennal joints each with two black marks on under side, the inner mark on the first joint linear, straight, its distal end sometimes curving outward toward the outer spot which may be either small and round or triangular and prolonged obliquely outward. Inner spot on second joint twice as long as wide, nearly in line with that on basal joint; outer spot smaller, variable, round or elliptic, and rarely nearly obsolete. Abdomen beneath not darkened.

Measurements.

	Total	Tegmina		Hind femora	Antenna	Ovipositor
		Wide	Long			
Male.....	12–16	4–5	10 –12	7.5–8.5	24–28	
Female.....	14–18		9.5–11	7.5–8.5	24–28	4.5–5 mm.

This is the most abundant and generally distributed Tree-cricket in New England. While apparently most at home in the weedy jungles of pastures and along woodland edges, composed of asters, goldenrod, everlasting, St. John's-wort, Joe-Pye-weed, etc., it is also common on wild carrot in mowing-lands, among raspberry and blackberry bushes, in young birch thickets, in bush-grown pastures, and amid a great variety of other vegetation. It is often very plentiful where it occurs, and its song is heard almost continually in the afternoons of late summer and autumn. This is a soft, continuous trill, much higher in pitch than that of *Oe. niveus*, closely resembling that of *Oe. nigricornis* but sometimes seeming to lack the volume and intensity of the song of that species. It varies so much individually and according to temperature and acoustic conditions of the environment that it is not always possible to say with certainty which is which until the singer is captured.

This species oviposits chiefly in such weeds as goldenrod, wild carrot, aster, etc., usually placing the eggs in irregular rows made up of several groups of from two or three to half a dozen, in the pith of slender stems a fifth of an inch or less in diameter. The eggs differ from those of *Oe. nigricornis* in being more slender and pointed, and the microscopic protuberances of the egg-cap are

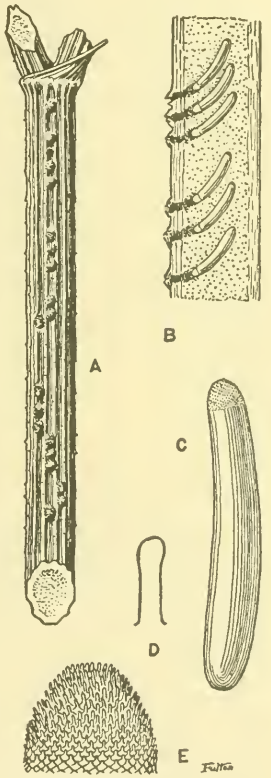


FIG. 72.—Four-spotted Tree-cricket, *Oecanthus quadripunctatus*. *A*, egg-punctures in wild carrot (x 1½); *B*, longitudinal section of same (x 3); *C*, egg (x 15); *D*, projection of egg-cap (x 500); *E*, egg-cap (x 50). (After Fulton.)

cylindrical, three times as long as broad, and slightly enlarged at tip.

I have taken this Tree-cricket from Hoxie and Brunswick, Me., and Woodstock, Vt., southward to Nantucket and Block Island, from August 13 to October 9. It is plentiful thoughout southern New England.

Pine Tree-cricket.

Oecanthus pini Beutenmüller.

Figs. 66 E, 73; Plate 17, fig. A; Plate 19, fig. A.

Oecanthus pini Beutenmüller, Journ. N. Y. Ent. Soc., vol. 2, p. 56 (1894).—Scudder, Psyche, vol. 9, p. 119 (1900).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 160 (1911).

Head and pronotum dull brown, the latter with a pale stripe on each side. Abdomen dull brown beneath, bordered by narrow, sharply defined cream-colored stripes; sides dull brown. Antennae dull brown, the first and second segments pale brown with black markings beneath, the first with a long line near inner edge and a spot or (typically) an oblique line near outer end, the second with two short, parallel longitudinal lines.

Measurements.

	Total	Tegmina	
		Wide	Long
Male	14–16	5	12–13
Female			12

This Tree-cricket is described as being found only in pine trees and usually high up, making it difficult both to observe and to secure. It oviposits in the pith and wood of the smaller twigs of the pitch pine[1] from one- to three-eighths of an inch in diameter, the punctures being placed in rows but widely apart from each other, often at the upper end of the elongate scales covering the twig. In captivity some females placed their eggs in apple twigs and wild-carrot stalks, probably because the pine twigs at hand had become dry and hard. In no case did they use white or Austrian pines. The protuberances of the egg-cap are flattened, about twice as long as broad, and half as thick, tapering slightly to a broad rounded tip.

[1] In New Jersey it frequents also the scrub pine.

This Tree-cricket was described from northeastern Connecticut and has been recorded from as far south as North Carolina and Georgia. Its range in New England is as yet a subject of conjecture but it has been reported from as far north as Gloucester, Mass. I have taken it at West Chop on Martha's Vineyard, and at Wareham,. Mass.

"Its song is a continuous, soft and metallic *reeeeeeeee* with numerous undulations. When many individuals are heard together, their stridulations sound not unlike the jingling of sleigh-bells at a distance" (Beutenmüller). It resembles that of *Oe. nigricornis* and *Oe. quadripunctatus* but is lower in pitch and like theirs is frequently given in late afternoon as well as at night.

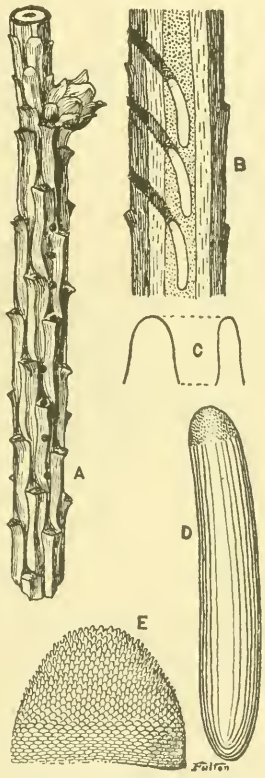


Fig. 73.—Pine Tree-cricket, *Oecanthus pini*. *A*, egg-punctures in pine (x 1½); *B*, longitudinal section of the same (x 3); *C*, projection of egg-cap, two views of the same structure (x 500); *D*, egg (x 15); *E*, egg-cap (x 50). (After Fulton.)

Two-spotted Tree-cricket.

Neoxabea bipunctata (DeGeer).

Figs. 66 I, 74.

Gryllus bipunctatus DeGeer, Mém. Hist. Ins., vol. 52, p. 523 (1773).

Oecanthus bipunctatus Scudder, Psyche, vol. 9, p. 104 (1900).

Xabea bipunctata Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 161 (1911).

This insect has the general form of an *Oecanthus*, but differs much in the details of its structure, and in the color of the female. The basal antennal joint is tuberculate beneath, the pronotum is elongate and oddly sculptured, the hind tibiae lack both spines and serrations, and the cerci and subgenital plate are peculiar.

Color: pinkish white to pinkish brown; tegmina of female with two dusky spots, one near base, another near center; of male un-

spotted. Basal joints of antennae unmarked. The wings extend far beyond the tegmina.

Measurements.

	Total	Body	Tegmina	Hind femora	Ovipositor	Antenna
Female.....	25	16	11.5	9	5	27 mm.

This large and peculiar Tree-cricket is rare in New England and as yet only a few examples have been found there; these were taken in southern Connecticut. On August 30, 1892, I captured a female at New Haven but do not recall the circumstances (recorded by Scudder,—List). Walden has since reported it from New Canaan and Portland on August 14 and September 11. Extralimitally it has been recorded from Indiana, Maryland, and Georgia, and Scudder states its distribution as the southern part of the United States east of the Great Plains.

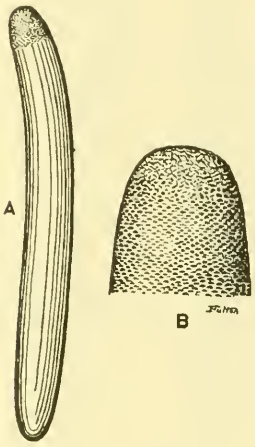


Fig. 74.—Two-spotted Tree-cricket, *Neoxabea bipunctata*. *A*, egg (x 15); *B*, egg-cap (x 50). (After Fulton.)

In habits it is said to be extremely retiring, living in dense tangles of wild grape vines and forest undergrowth or in low trees near dwellings. Its song consists of a series of low, deep trills separated by short intervals.

SUBFAMILY TRIGONIDIINAE.

But a single species of this subfamily is found in New England and that occurs locally only on the southern shore of Connecticut, so far as known at present.

Striped Bush-cricket.

Anaxipha exigua (Say).

Acheta exigua Say, Journ. Acad. Nat. Sci. Phila., ser. 1, vol. 4, p. 309 (1825).
Anaxipha exigua Blatchley, 27th Ann. Rept. Dept. Geol. Nat. Resources Indiana, p. 455 (1903).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 162 (1911).

Pale brown, darker on the sides and middle of pronotum; ovipositor dark brown; face with brown streaks down the middle and

from each eye to mouth; a brown streak along middle of outer face of hind femora. Eyes brownish black, very large and prominent. Vertex hollowed out. Pronotum of male narrowed anteriorly, of female nearly parallel-sided. Tegmina translucent, of male broad, parallel-sided, rounded apically, covering abdomen; of female rather narrow, truncate, veins prominent, covering two-thirds to three-quarters of abdomen. Cerci long, of female nearly reaching tip of ovipositor, clothed with long and delicate hairs. Hind femora rather slender, about three times as long as wide. Palpi with last joint flattened, funnel-shaped, a little longer than the preceding segment. Ovipositor short, strongly upcurved, the basal half elliptic, slightly compressed in section, the distal half strongly compressed, separated from the basal half by an oblique ridge, the apex saber-like, acutely pointed, with both edges minutely serrate. Hind tibiae armed on apical half with two rows of long, delicate, equal spines, without serrations between them.

Measurements.

	Body	Tegmina	Hind femora	Ovipositor
Male	6–6.4	4.5	4.5	
Female	5–7.5	3.5	5–6.5	3 mm.

This dainty little Cricket, somewhat resembling a small, faded-out *Nemobius*, lives on bushes instead of on the ground. It is found locally among the tangled vegetation in or near salt-marshes and inland swamps from southern New England to Florida, Texas, and Nebraska. It is very active, difficult to capture, and owing to its small size and pale color is likely to be overlooked unless it occurs in abundance. In Indiana it matures about August 1. Walden records it from Westbrook, Ct., August 30. Persistent search will probably reveal its presence locally on much of the southern coast of New England.

SUBFAMILY ENEOPTERINAE.

It is believed that no members of this subfamily naturally inhabit New England. An exotic species of *Hapithus* maintained itself for several years under artificial conditions in the conservatory of the Botanic Garden of Harvard University at Cambridge, Mass.

Hapithus vagus Morse.

Apithes agitator Scudder, Psyche, vol. 9, p. 105, Sept. 1900.
Hapithus vagus Morse, Psyche, vol. 23, p. 179, Dec. 1916.

This adventive species is a brown, robust-bodied Cricket about three-fifths of an inch long, which was accidentally introduced into the greenhouse of the Botanic Garden at Cambridge, Mass., and maintained itself there for five or six years about the beginning of this century.

Nothing is known as to the country of its origin, at least definitely. It was injurious through its propensity for nibbling the tender green leaves of many varieties of plants, especially ferns. Its final extermination in the greenhouse was brought about in part by the introduction of a number of small frogs which snapped up the Crickets greedily at every opportunity.

THE BURROWING OR MOLE-CRICKETS—GRYLLOTALPINAE AND TRIDACTYLINAE.

The Mole-crickets present an interesting instance of adaptation of insect structure to a special and unusual mode of life—tunneling through the soil—an adaptation in which the same mechanical principles are involved as in the modification of vertebrate structure shown by the mole; consequently the name of Mole-cricket is exceptionally apt.

The antennae are relatively short and insignificant, while the cerci are unusually long and well developed, serving as efficient guides during backward movement in the underground galleries; the head is of medium size, rounded, armed with powerful, protruding jaws for cutting rootlets and opening a way through the soil; the pronotum is very large, strongly built, and of such a shape, combined with the head, as most effectively to prepare a passage through the soil for the rest of the body. The fore legs are enormously developed, being relatively long, exceptionally broad and powerful, with flattened, sharp-edged, tooth-like projections as effective as spades for digging and displacing the soil. In the true or large Mole-crickets (*Gryllotalpa* and *Scapteriscus*) the hind femora are relatively small and weak and are of little use as leaping organs, in strong contrast with their development in most of the family. The ovipositor has disappeared as an external organ, being in the way and no longer needed by a burrow-

ing animal whose eggs are laid in underground passages excavated by other tools. All of these peculiar features of structure are evidently correlated with the subterranean mode of life.

"With a pair of fore-feet, curiously adapted to the purpose, it burrows and works under ground like the mole, raising a ridge as it proceeds, but seldom throwing up hillocks" (Gilbert White).

Key to Species of Mole-crickets.

A. Large species, one to one and a half inches long (25 to 37 mm.). Hind femora scarcely longer than fore femora. Hind tarsi distinct, three-jointed. Ocelli two.....Subfamily GRYLLOTALPINAE.
B. Hind tibiae armed on distal half of inner (hinder) dorsal edge with four spines.....European Mole-cricket, *Gryllotalpa gryllotalpa*, p. 419.
BB. Hind tibiae not so armed.
American Mole-cricket, *G. hexadactyla*, p. 417.
AA. Small species, about one-third of an inch (8 to 9 mm.) long. Hind femora greatly enlarged, four to five times as long as fore femora. Hind tarsi spur-like, one-jointed. Ocelli three. Subfamily TRIDACTYLINAE.
Pygmy Mole-cricket, *Tridactylus apicialis*, p. 420.

AMERICAN MOLE-CRICKET.

Gryllotalpa hexadactyla Perty.

Fig. 75.

Gryllotalpa hexadactyla PERTY, Del. Anim. Art., p. 119, pl. 23, fig. 9 (1830–1834).
Gryllotalpa brevipennis HARRIS, Treatise, 3d ed., p. 149 (1862).
Gryllotalpa borealis HARRIS, Treatise, 3d ed., p. 149, note (1862).—FERNALD, Orth. N. E., p. 14 (1888).—WALDEN, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 149 (1911).
Gryllotalpa columbia FERNALD, Orth. N. E., p. 14 (1888).

Rusty brown to dark brown, paler beneath; the veins of the tegmina dark brown on a lighter ground.

Measurements.

	Body	Pronotum	Tegmina	Wings pass teg.	Hind femora
Male.....	22	8	7.5	2	7
Female.....	25–31	9–10	9–13	2–4 or 13–14	7.5–8 mm.

This is a distinctly smaller and less robustly built insect than the European species, but is otherwise generally similar in structure and appearance, though readily recognized by the diagnostic characters pointed out elsewhere. The wings vary greatly in

length, examples usually falling into two series, one in which the wings project but little beyond the end of the tegmina, falling short of the end of the abdomen, and another in which they greatly surpass the abdomen, extending halfway to the end of the long caudal cerci. The protuberance on the end of the fore trochanter is semicircular in outline and thickly covered with spinous hairs.

Fig. 75.—American Mole-cricket, *Gryllotalpa hexadactyla*. (After Blatchley.)

The Mole-cricket lives in damp soils, usually near open water, often on the shores of ponds and streams, where it drives its subterranean tunnels just beneath the surface, throwing up long, circuitous ridges, by which its presence may be known. The eggs are laid in lateral chambers large enough to permit the Cricket to turn around, in masses of from 60 to 100, and often adhere to rootlets.

Though very widely distributed over a great part of North and South America, it is a relatively scarce and local insect in New England and is only exceptionally met with in the field. Occasionally a long-winged individual, attracted by lights at night, is captured by an observant person and referred as a curiosity to the entomologist for information; and rarely a suddenly opened burrow beneath some sheltering tuft of grass or sedge yields one or even several examples, perhaps a female with a numerous brood.

The song is singularly batrachian in quality, a low-toned *querr, querr,* or *grüü, grüü,* like that of a small toad or frog, and when heard in a meadow or from the edge of a pond or stream is almost certain to be attributed to such creatures by the uninformed. It is not infrequently heard locally in moist places on cloudy days or toward night-fall in early autumn, but to find and capture the insect producing it is a difficult matter. The note is usually sounded in the burrow, and this very likely gives a subterranean quality to its tone. In the Tennessee mountains I have heard several individuals chirping at once from different points in the bed of a shallow stream, among the protruding stones of which

they were hidden, but where it was practically impossible to secure them.

The Mole-cricket doubtless occurs throughout New England, having been reported from the island of Anticosti, New Hampshire, Vermont, Connecticut, and Massachusetts, including Nantucket.

European Mole-cricket.

Gryllotalpa gryllotalpa (Linné).

Gryllus (*Acheta*) *gryllotalpa* Linné, Syst. Nat., ed. 10, vol. 1, p. 428 (1758).

Dark brown above, the fore legs rufous; yellowish brown beneath and on sides of tegmina at base; tegminal veins brownish black on a yellowish-brown ground. Entire body covered with a short, dense pile.

This species is at once distinguished from the American Mole-cricket by the spined hind tibiae, the extremely large pronotum, and the conspicuous blade-shaped (cultriform) process of the trochanter of the front legs.

Measurements.

	Body	Pronotum	Tegmina	Wings pass tegmina	Hind femora
Male.....	39	13.5	16	18	11.5 mm.

The European Mole-cricket as a New England insect is known only from three specimens once in the collection of Nantucket insects of the Maria Mitchell Scientific Association of that place. The species is unquestionably adventive and was doubtless brought over in some stage in the soil with Old World plants of which many have been commercially introduced on the island and flourish there, among them heather, Scotch broom, and pines. It is evidently a parallel case with that of the Short-winged European Bush-katydid, *Leptophyes*, likewise found on the island.

Whether it has become fully established (as it is reported to be in New Jersey) is another question. If so, it is likely to spread to the mainland, and may in time become obnoxious, as it sometimes is in Europe, through the cutting of the roots of grass and other plants while burrowing through the soil.

The cutting is said by Sharp to be done by the scissors-like action of the front tarsi on the tibiae. At first glance this may

seem plausible but a critical examination indicates that it is highly improbable if not impossible, since the edges of the tarsal joints are not specially sharp, are not closely applied to the tibial projections, and the leverage is extremely poor. On the contrary, there can be little question that it is done by the efficient shear-like action of the powerful mandibles.

If this Cricket still exists on the island it should be possible to detect its presence by its song, which is probably sufficiently distinctive to differentiate it from that of our native species, which is also found there.

Pygmy Mole-cricket.

Tridactylus apicialis Say.

Figs. 76, 77.

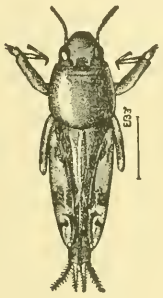
Tridactylus apicialis Say, Journ. Acad. Nat. Sci. Phila., ser. 1, vol. 4, p. 310 (1825).—Scudder, Boston Journ. Nat. Hist., vol. 7, p. 425 (1862).

Tridactylus terminalis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 425 (1862).—Fernald, Orth. N. E., p. 13 (1888).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 380 (1873).—Morse, Psyche, vol. 9, p. 197 (1901).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 150 (1911).

Head rounded, smooth. Pronotum as wide as long, its front margin straight, hind margin a little convex, lateral margins concave, front and hind angles about rectangular. The wings pass the end of the body about 1 mm. Tegmina half as long as wings, alike in both sexes. Stridulatory organs not visible. Hind femora very large, reaching end of body, elongate elliptic, more than one-third as wide as long. Hind tarsi reduced to a single joint appressed to the hind tibiae when at rest; tibial spurs as long as tarsal joint, directed forward when at rest.

The fore legs are the shortest of the three pairs and in the female are rather stout. The front tibia is somewhat ovate in outline, and bears distally four prominent, equidistant teeth; its convex hinder face is thickly set with hairs and bears a row of spinous hairs on the outer margin, the very slender tarsus being inserted between the first and second teeth and lying in a recess on the anterior surface of the tibia. This description of the tibia applies also to some males. In others a remarkable bifurcation is present, the tibia loses its hairy covering, the innermost tooth nearly disappears, the second is greatly prolonged, the branch that

bears it leaves the other at nearly a right angle, and the femur becomes greatly enlarged and acquires a series of teeth on the under side. The two extremes are, however, connected by a full series of intermediate stages, and may be found in specimens taken at the same time and place. No explanation of the cause



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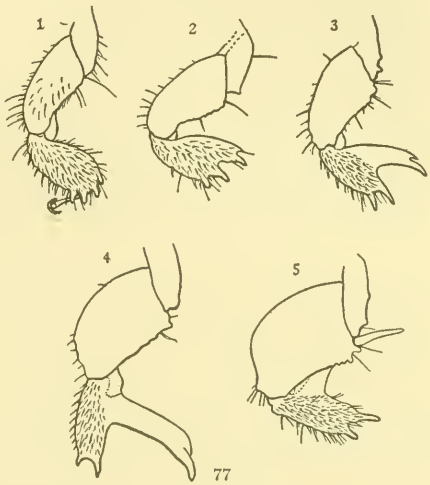

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Fig. 76.—Pygmy Mole-cricket, *Tridactylus apicialis*. (After Lugger.)

Fig. 77.—Pygmy Mole-cricket, *Tridactylus apicialis*. Left front leg seen from behind. *1*, female; *2*, male; *3*, male; *4*, male; *5*, male, tibia closed upon the femur. A. P. Morse, del.

of the difference or of the particular function of the extraordinary bifurcate pattern of tibia has ever been suggested.

The sexes resemble each other strongly but the female may be distinguished by the penultimate ventral segment of the abdomen having the hinder angles rounded and being very slightly emarginate in the middle, often with a brown thickening bordering the emargination.

The body is smooth and shining, free from the dense pile characteristic of *Gryllotalpa*. The general effect is of a black insect varied with white spots on the hind femora and beneath. The young are brown and white.

Measurements.

	Total	Body	Hind femora	Wings surpass abdomen
Average.....	8	7	8	1 mm.

Pygmy Mole-crickets live on and in the damp sand on the shores of ponds and streams. They are inconspicuous little creatures, not likely to be noticed unless captured in the sweep-net or when their presence is betrayed by the ridges thrown up during their subterranean tunnelings. They may be seen rarely on the surface of the ground or at the entrance of the burrow, but are extremely active and alert and disappear almost instantaneously, with prodigious leaps. Blatchley says that they often leap to a height of five feet and a distance twice as great.

This species has been reported from Connecticut, and from Cambridge, Winchester, and Nantucket, Massachusetts. At the last locality I have found adults numerous on July 13; a few nymphs on the same date and September 10.

LOCUSTS, SHORT-HORNED GRASSHOPPERS, "GRASSHOPPERS"—Family ACRIDIDAE.

The members of this family are characterized by relatively short antennae, usually shorter than the body or body and wings; tarsi usually of but three joints (in one subfamily reduced to two except on the posterior pair); hearing organs on the sides of the basal segment of the abdomen; and stridulating rasps (when present) on the inner side of the hind thighs or the external surface of the wing-covers. The antennae are thread-like, sometimes considerably enlarged and prismatic at base, or slightly enlarged and flattened at tip.

Anatomy, Habits, etc.—An excellent guide to the anatomy of a member of this family is "The Anatomy of the Carolina Locust," by Robert E. Snodgrass, published by the Washington Agricultural College and School of Science, Pullman, Washington (State) (1903, 50 pp., 6 pls.). This I have used freely in the earlier pages. It treats of both external and internal anatomy and histology, and is well illustrated. Comstock's "Elements of Insect Anatomy," well known to every Cornell student of entomology, contains a chapter on the anatomy of the Red-legged Locust, but lacks illustrations. A popular account of the same subject, with sketches, by Professor Mary A. Willcox, appeared in the Observer, for May, 1896, and brief directions for study in the number for July following. The three volumes of Reports of the United States Entomological Commission on the Rocky Mountain Locust, etc., 1878–1883, contain a wealth of information on many topics relating to this species and to migratory Locusts in general, their habits, enemies, methods of extermination, etc. Two papers giving more recent methods are the following: "Grasshopper Control" (Farmers' Bulletin, U. S. Dept. Agric., no. 747, 20 pp., 1916); "Efficiency and Economy in Grasshopper Control," by E. D. Ball (Journ. Econ. Ent., vol. 10, p. 135–138, 1917).

Their general anatomy and habits have been treated at length in the preceding chapters and need not be further dwelt on here. Details of structure, habits, and distribution are stated in the keys for identification and under the specific headings.

To this family belong the true Locusts of the Old World, which are mentioned in holy writ as one of the plagues of Egypt, and which furnished food in the desert for John the Baptist. The most noted member of the family in this country is the Rocky Mountain Locust or Hateful Grasshopper (*Melanoplus spretus*), a near relative of our New England Lesser Locust (*M. m. atlanis*). It caused great damage in the Middle West in the late '70's.

In America these insects are more commonly called Grasshoppers than the members of the family Tettigoniidae (the true or Long-horned Grasshoppers); and the tangle of scientific names applied to the various families and subfamilies of Orthoptera is such as to discourage all but the most determined students.

The changes in the names of the families of saltatorial Orthoptera and the subfamilies of Acrididae which seem to be necessary in order to conform to the nomenclature now accepted may be stated briefly as follows:

Former names.	*Now current.*
Locustidae (Long-horned Grasshoppers)	Tettigoniidae (from *Tettigonia*)
Acridiidae (Locusts) (from *Acridium*)	Acrididae (from *Acrida*)
Tryxalinae	Acridinae (from *Acrida*)
Acridiinae (from *Acridium*)	Locustinae (from *Locusta*)
Tettiginae (from *Tettix*)	Acrydiinae (from *Acrydium*)

It is unfortunate that such confusion of names should have arisen; and much to be desired that permanence of terminology be soon secured, even if all the rules intended to bring about that end be broken in so doing!

Systematic works.—"A Synopsis of the North American Acrididae" by Cyrus Thomas (1873) included the entire continent. It is now quite out of date and nothing has yet appeared covering the same field. A manual of this family including the entire country is greatly needed but it is probably too soon to prepare it with adequate results. Several of the larger groups were revised fifteen to twenty years ago, and although they are greatly in need of revision at the present time, the works are still helpful. Among the principal ones are the following:

Acridinae: McNeill, J., "Revision of the Truxalinae of North America," Proc. Davenport Acad. Nat. Sci., vol. 6, p. 179–274, pl. 1–6 (1897).

OEDIPODINAE: Saussure, H. de., "Prodromus Oedipodiorum," Geneva, 254 pp., 1 pl. (1884) and "Additamenta ad Prodromum Oedipodiorum," Geneva, 180 pp., 1 pl. (1888). A classic and still valuable work on this subfamily.—McNeill, J., "Revision of the Orthopteran genus Trimerotropis." Proc. U. S. Nat. Mus., vol. 23, p. 393–449 (1901).

LOCUSTINAE: Scudder, S. H., "Revision of the Orthopteran group Melanopli," etc. Proc. U. S. Nat. Mus., vol. 20, p. 1–421, pl. 1–26 (1897); "Supplement to a Revision of the Melanopli." Proc. Davenport Acad. Nat. Sci., vol. 7, p. 157–205, pl. 7–9 (1899).

ACRYDIINAE: Hancock, J. L., "The Tettigidae of North America." 188 pp., 11 pls. (1902).

Many faunistic papers published since 1900, on the Orthoptera of particular districts, notably those by Caudell, Davis, Fox, Morse, and especially Rehn and Hebard, as well as purely systematic ones by the same authors, also contain notes on the taxonomy of various species and genera of the family.

Key to Subfamilies of New England Acrididae.

A. Pronotum of normal size, not covering the abdomen. Claw-pads (pulvilli) present between the tarsal claws. All tarsi three-jointed.

B. Prosternum not spined,—flat, convex, or at most with an obtuse tubercle.

C. Hind margin of pronotum not or but little produced,—truncate, convex, or very obtusely angulate. Disk of pronotum without high median carina. Face usually retreating, and angulate at junction with vertex....Slant-faced Locusts, ACRIDINAE (*Tryxalinae*), p. 425.

CC. Hind margin of pronotum strongly produced,—acute, right-angled, or nearly so. Pronotum usually with distinct median keel. Face usually nearly vertical, and rounded at meeting with vertex.
Band-winged Locusts, OEDIPODINAE, p. 447.

BB. Prosternum with a prominent conical or cylindrical spine projecting ventrad to the level of the distal end of the coxa.
Spine-breasted or Spur-throated Locusts, LOCUSTINAE (*Acridiinae*), p. 480.

AA. Pronotum covering all or nearly all of the abdomen. Claw-pads absent. Front and middle tarsi two-jointed, hind tarsi three-jointed.
Pygmy Locusts, ACRYDIINAE (*Tettiginae*), p. 525.

SLANT-FACED LOCUSTS; MEADOW LOCUSTS—ACRIDINAE (*Tryxalinae of authors*).

The most noticeable peculiarity of the members of this subfamily is the strongly retreating face and projecting vertex, the latter being nearly horizontal and its plane meeting that of the face at an acute angle. The prosternum lacks the prominent spine characteristic of the Locustinae (Acridiinae) though in two

genera (*Pseudopomala*, *Mecostethus*) it is noticeably protuberant. The pronotum usually presents a flattened dorsal surface bounded by distinct lateral carinae, the median carina is but little developed, never crest-like, the prozone often exceeds the metazone in length and sometimes equals it in width. The tegmina and wings are often abbreviated, but are very variable and sometimes are of full length in the same species in which they are customarily short. The tarsal pulvilli are large, perhaps in correlation with the habit of perching on plants.

These Locusts are usually of medium size, of graceful, often slender, proportions, and attractive appearance. The coloration is usually highly protective in character, typically matching the green, brown, and gray of the plant background. It may be either uniform or conspicuously varied with darker and lighter spots and streaks, and occasionally presents brighter hues. The wings are transparent.

The characters most valuable and most used in distinguishing the species and genera are those drawn from the form of the head and pronotum, the venation of the tegmina, and to a less extent the form of the antennae and subgenital plate and ovipositor.

Their flight is silent except for a slight rustling of the wings, but most, probably all, of our species stridulate when at rest by scraping the inner side of the hind thighs against the tegmina. The rasp which sets the tegmina in vibration is borne sometimes by the femur, sometimes by the tegmen, and varies in character and extent with the species.

These Locusts inhabit by preference open grassy lands heavily clothed with vegetation, upon which they feed and typically perch when at rest, instead of on the ground like the Band-winged (Oedipodinae) and Pygmy Locusts (Acrydiinae). While several species are more abundant in dry upland fields, others are to be found only in damp meadows and even wet bogs and marshes where the soil is always saturated with water and completely submerged at times.

None of our species has attracted particular attention as an agricultural pest, but three or four which occur locally in great abundance in pastures and mowing-lands must consume a very large quantity of feed and appreciably diminish the amount available for stock.

Key to the New England Species of Acridinae.

(See Plate 20.)

A. Antennae much enlarged at base, tapering to a point, the segments prismatic.....Bunch-grass Locust, *Pseudopomala brachyptera*, p. 428.

AA. Antennae slightly enlarged at tip, scarcely as long as head and pronotum. Crown of head and disk of pronotum with a supernumerary carina on each side of the median. Inner apical spurs of hind tibiae of very unequal length.....Velvet-striped Locust, *Eritettix simplex*, p. 430.

AAA. Antennae thread-like. No supernumerary carinae. Inner apical spurs of hind tibiae about equal.

B. Tegmina without well-developed intercalary vein.

C. Foveolae visible from above as deep, linear impressions.
Meadow Locust, *Chorthippus curtipennis*, p. 440.

CC. Foveolae not visible from above,—often shallow or wanting.

D. Antennae short, about equal to head and pronotum together. Wings functional, though sometimes quite small, with an opaque thickening on front margin at apical third.

E. Sides of pronotum elongate, the length on the dorsal margin greater than the depth; lateral carinae parallel and disk of one color. Foveolae absent.
Bicolored Locust, *Dichromorpha viridis*, p. 432.

EE. Sides of pronotum not elongate; lateral carinae more or less divergent before and behind, and disk particolored on metazone. Foveolae usually present on front of vertex.

F. Vertex of head blunt, rounded, obtuse (♀), or rectangular (♂), scarcely narrowed between eyes, its central depression close to apex. Lateral carinae of pronotum little incurved, the distance between them but little greater at hind than at front margin, especially in female. Prozone longer than metazone.....Pasture Locust, *Orphulella speciosa*, p. 435.

FF. Vertex of head rectangular, or a little acute in male, a little narrowed between the eyes, its central depression removed from apex one-third (♂) to one-fourth (♀) the width of the vertex. Lateral carinae of pronotum strongly incurved, and the distance between them at hind margin much greater than at front margin. Prozone and metazone about equal on mid-line.
Spotted-winged Locust, *Orphulella pelidna*, p. 436.

FFF. Vertex of head acute, the sides often concave in male, distinctly narrowed between eyes, the central depression farther removed from apex. Lateral carinae of pronotum little incurved but the distance between them much greater at hind than at front margin. Prozone longer than metazone.
Salt-marsh Locust, *Orphulella olivacea*, p. 437.

DD. Antennae long, flattened, of male twice, of female one and one-half times as long as head and pronotum together. Wings abortive (rarely functional and then lacking opaque spot on front margin). . . . Sprinkled Locust, *Chloealtis conspersa*, p. 438.

BB. Tegmina with well-developed, elevated intercalary vein.

G. Lateral carinae of pronotum distinctly divergent behind. Prozone shorter than metazone. Anterior distal intercalary venules (especially in male) oblique. Sternum 9 of male not black on mid-line.

H. A conspicuous pale streak at base of tegmina near front margin. Intercalary vein of male with low, dull teeth.
Striped Sedge-locust, *Mecostethus lineatus*, p. 442.

HH. Tegmina without pale stripe as above. Intercalary vein of male with high, acute teeth
Northern Sedge-locust, *Mecostethus gracilis*, p. 444.

GG. Lateral carinae of pronotum sub-parallel. Prozone and metazone of equal length. Tegmina without pale stripe. Anterior distal intercalary venules nearly transverse. Sternum 9 of male with black spot on median line.
Broad-winged Sedge-locust, *Mecostethus platypterus*, p. 446.

Bunch-grass Locust.

Pseudopomala brachyptera (Scudder).

Plate 12, fig. 1; Plate 20, fig. 1–3.

Opomala brachyptera Scudder, Boston Journ. Nat. Hist., vol. 7, p. 454 (1862).—Fernald, Orth. N. E., p. 35 (1888).

Pseudopomala brachyptera Morse, Psyche, vol. 7, p. 343 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 73 (1911).

A medium-sized, slenderly built Locust with very strongly retreating face. Vertex elongate, projecting in front of eyes nearly their length, bluntly rounded, once and a half or twice as wide as an eye; foveolae absent; median carina prominent, disappearing posteriorly between the eyes into the convex crown. In side view the face is plane or slightly concave, protuberant opposite base of antennae, and rounded subangulate at union with vertex. Antennae once and a half (♂) or but little (♀) longer than head and pronotum together, enlarged at base, prismatic, tapering to a point. Disk of pronotum nearly flat, front and hind margins truncate, sides parallel, carinae equally developed, distinct but not prominent, metazone two-thirds as long as prozone, the lateral lobes much longer than deep, with anterior margin strongly oblique, hind margin concave,

ventral margin but little sinuous, parallel with dorsal. Prosternum with a low, conical, rather sharply pointed protuberance. Tegmina of male covering half of abdomen, long and narrow, rounded at apex, the apical half of the front margin transparent, the scapular area rather wide and regularly reticulated; in the female the tegmina are much abbreviated, covering hardly more than a third of the abdomen, tapering in the distal half to an acute point. Wings abortive. Examples of both sexes with fully developed tegmina and wings are not rare. Legs very slender, the front and middle pairs very short, the hind pair elongate, the hind femora very slender, attenuate. Abdomen elongate, strongly keeled above. Subgenital plate of male elongate, conical, three times as long as basal width. Ovipositor of female short, barely exposed, with strongly recurved tips and toothed at base of scoop.

Color: light brown (♂) or pale gray (♀), either uniform or faintly marked with darker spots and streaks; occasionally the female presents a decidedly streaked appearance with darker longitudinal markings which are most noticeable on the top of head, sides of pronotum, and tegmina.

Measurements.

	Body	Tegmina (short-winged)	Tegmina (long-winged)	Hind femora	Antenna
Male	23.5–27	9–12.5	15.5–17	13.5–15.5	9.5–11.5
Female ..	27.5–29.5	7–11	18 –22	14 –19	8.5–10 mm.

This singular Locust is not uncommon locally among the coarser grasses in wild and uncultivated lands, occurring especially on a species of bunch-grass (*Andropogon scoparius*) everywhere abundant on sterile soils. I have found it also on beach-grass (*Ammophila arenaria*) and timothy (*Phleum pratense*).

It leaps well, and though fairly active it is not shy, but when approached closely seeks safety by sidling around the grass stems rather than through actual retreat. This is a method of escape for which its relatively sluggish habits, linear form, and dead-grass color fit it especially well. However, while it customarily relies for protection on these means and for escape solely upon its legs (of necessity), I once saw a long-winged female fly a distance of several feet, indicating that in this case, at least, the re-development of the wings had been accompanied by the

power to use them. The long-winged form, while not common, cannot be considered rare, and sometimes several examples may be found in a small colony.

This Locust must be watched in its own home to have its beauty and the significance of its form and coloring fully appreciated. Its singular, almost grotesque, yet graceful shape interests even the casual observer; and its coloring of pale gray or lilaceous drab, often varied with darker brown and dull white, especially frequent in the female, gives it the appearance of being clothed with a delicate bloom. The possibility of discovering something regarding its stridulatory habits should lend interest to the acquaintance, little or nothing being known regarding them, though the apparatus is highly developed.

The young are not uncommon in June and July, and adults can be found from the first week in July until at least the middle of September. It is known from Fryeburg, Me.; Jaffrey, N. H.; Woodstock, Vt.; and many localities in Connecticut and Massachusetts, including the island of Martha's Vineyard.

Velvet-striped Locust.

Eritettix simplex (Scudder).

Figs. 78, 79.

Gomphocerus simplex Scudder, Trans. Amer. Ent. Soc., vol. 2, p. 305 (1869). *Eritettix carinatus* Britton, Psyche, vol. 11, p. 23 (1904).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 75 (1911).

Head sharp-pointed from above. Vertex horizontal, projecting well in advance of eyes, lateral margins and mid-carina elevated, especially in male. Median carina continued on crown and occiput, flanked by a pair of equally well-developed supernumerary carinae arising opposite anterior end of eyes. Pronotum with sides parallel, the lateral carinae very slightly incurved at middle; lateral and median carinae equally developed, cut once by principal sulcus; a pair of low supernumerary carinae continuous with those of the crown of the head. Tegmina and wings fully developed. Hind femora rather stout. Subgenital plate of male short, very bluntly conical. Ovipositor very little exposed.

Color: brown, often with pale gray or yellowish stripes on

carinae of head and pronotum, on tegmina and hind femora, and with velvety black stripes bordering those on the head and pronotum. Probably additional color patterns, including a green form, will be noted as specimens accumulate, but I have seen less than half a dozen examples from New England and these I owe to the kindness of Mr. B. H. Walden of the Connecticut Agricultural Experiment Station.

Measurements.

	Total	Tegmina	Hind femora	Antenna
Male	16–17	11–12.5	9–10	5
Female	23–25	12–13.5	13–16	5.5 mm.

This is a relatively rare species in New England and does not seem to be abundant outside our borders. It was not discovered in our territory until very recently, and has thus far been taken only in Connecticut. "It occurs on light, dry soil where there is but little vegetation" (Walden), such as in abandoned fields and dry pastures. Connecticut specimens bear dates from May 25 to June 30, October 31, and nymphs on November 2. Farther south (Maryland to Georgia) nymphs are common in July and August and adults are recorded in April, May, June, and July, the majority of them in May and June (Rehn and Hebard). These data apparently indicate that the species usually hibernates in

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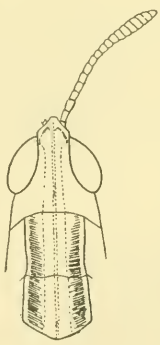

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Fig. 78.—Velvet-striped Locust, *Eritettix simplex*. (After Lugger.)

Fig. 79.—Same. Dorsal view of head and pronotum to show form of antennae and supernumerary carinae. (After Walden.)

the late nymph or adult stage. Walden records it from Centerville, East Haven, Hamden, Mt. Carmel, New Haven, Orange, and Southington, Ct.

Bicolored Locust; Short-winged Green Locust.

Dichromorpha viridis (Scudder).

Fig. 80; Plate 20, figs. 4, 5.

Chloealtis viridis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 455 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 374 (1873).—Fernald, Orth. N. E., p. 36 (1888).

Dichromorpha viridis Morse, Psyche, vol. 7, p. 383 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 76 (1911).

Vertex of head horizontal, shorter than broad, the margins sloping upward from a semicircular depression, the mid-carina absent. Pronotum with sides parallel, lateral and median carinae equally developed; front margin truncate, hind margin very slightly rounded or angulate. Tegmina widened on costal margin opposite base of hind femora, tapering rapidly in both directions. Subgenital plate of male very short and bluntly conical. Ovipositor valves moderately exserted, stout, short-pointed, smooth-edged.

Fig. 80.—Bicolored Locust, *Dichromorpha viridis*. Female. (After Lugger.)

Color: in general, almost uniform grass-green or brown above; or, green above and with the sides of the head, pronotum, and lateral portion of closed tegmina varying from brown to fuscous. Beneath, pale grayish or yellowish green or brown.

Measurements.

	Body	Tegmina (long-winged)	Tegmina (usual)	Hind femora	Antenna
Male	15–16	14	6– 9	9.5–10.5	6.5–8.5
Female	23–27	19	8–10	14 –15	7–8 mm.

This Locust is dimorphic both in wing-length and in color. The tegmina vary from forty to fifty per cent in length in short-winged examples, and are nearly or quite double that length in the long-winged form. Long-winged males are

extremely rare; brown males are not common, usually less than half as plentiful as brown females, but the proportion of individuals of the two colors varies much locally, and, it is believed, according to the prevailing color of the environment.

The Bicolored Locust is a common species in southern New England in the latter part of the season, adults appearing in the latter half of July and lingering until late in October, having been recorded on the 23d of that month in Connecticut. It is most common in rich pastures and old mowing-lands on heavy soil, and delights especially in moist places such as are found in damp meadows and the vicinity of springs, brooks, and ponds, where the grass is dense and luxuriant throughout the season. This is perhaps the reason for the more generally prevalent green color, which renders it inconspicuous. Well protected by its coloration, it is a sluggish creature, and rarely uses its wings even when these are fully developed.

This Locust probably inhabits all quarters of Connecticut and Rhode Island, much of southern and central Massachusetts, and possibly reaches New Hampshire and Vermont in the Connecticut valley. At the time of publication of my "Notes" (1896) and article on the distribution of New England Locusts (1899) I had not found this species in the vicinity of Boston. In recent years, however, it has been captured in small numbers at several points in this district, *viz.*, Sherborn, Wellesley, Needham, and Sharon, Mass., but it is much less abundant here, even locally, than in Connecticut and farther south. Whether its appearance in this vicinity is due to recent invasion from the southwest, a possibility which I suggested in one of the papers cited, remains to be proved. If so, it will probably increase in numbers, become more generally distributed here, and continue to extend its range toward the northeast.

THE NEW ENGLAND SPECIES OF ORPHULELLA.

Our species of this genus resemble each other closely and for a long time two of them were not only generally confused but received several additional names applied chiefly to color variations. Critical study has since reduced these to synonyms. The third species, which is found only in salt-marshes in extreme southern New England, escaped notice until I had the good for-

tune to discover it in my first season's collecting. This one is not involved in the tangle of nomenclature woven around the others.

The first two are upland species and are dainty, attractively colored little "grasshoppers" which in late summer literally swarm in favorable localities and must in the aggregate do a large amount of damage to vegetation, especially in dry seasons. The salt-marsh species, while less pleasing in color and less important economically, is no less interesting from its restriction to a peculiar habitat and its close approximation in hue to the tints of its environment.

In general, these are Locusts of small size and rather slender form, with short antennae, and present a wide diversity of colors, ranging from nearly uniform brown or green to strikingly contrasted blackish patterns on the brown or green ground color, and occasionally with rose-red tegmina. Common variant patterns are primarily based on the breaking-up of the ground color into lengthwise areas by a dusky lateral stripe extending from each eye backward along the side of the disk of the pronotum and the middle of the tegmina; this is cut obliquely by the pale lateral carinae on the metazone and more or less broken by pale spots or broken up into dark spots. In addition, a pair of longitudinal dark stripes on the top of the head is of frequent occurrence; and the sides of the body and the outer face of the hind femora are often much varied, a metepisternal pale stripe and bands on the hind femora being often conspicuous.

The two upland species are replicas of each other in coloring; the Salt-marsh Locust exhibits the same patterns but in less striking contrast.

Besides the distinctions given in the key, which is condensed for the sake of brevity from that in my "Notes" (Psyche, vol. 7, p. 325, 1896), the following characters, likewise drawn therefrom, will prove additional aids to discrimination in doubtful cases. It must always be remembered, in regard to closely allied species, that individuals may vary so widely that specimens frequently cannot be determined with certainty from a single character, and the sum of many must be used.

Speciosa.—Foveolae of vertex shallow, triangular, scarcely discernible. Tegmina about reaching end of hind femora, often shorter, sometimes longer, tapering toward apex; ulnar area in male coarsely, often regularly, reticulated,

the anterior ulnar vein strongly approximated to the radial; in female usually slightly but distinctly nearer the radial, the widest part of the ulnar area wider than the discoidal area, spurious vein poorly developed or absent. Apex of wings rarely with spurious veins between the branches of radial.

Pelidna.—Foveolae distinct but rather shallow, narrowly triangular. Tegmina extending beyond the hind femora, apex scarcely tapering, sides subparallel; ulnar area in male usually closely reticulated (sometimes with spurious vein), but little wider than discoidal area; female with ulnar and discoidal areas of equal width, the anterior ulnar vein parallel to radial and the ulnar area divided by a long spurious vein. Apex of wings usually with well-developed spurious veins between branches of radial vein.

Olivacea.—Foveolae distinct but rather shallow, narrowly triangular. Tegmina extending beyond hind femora, tapering toward apex; ulnar area in male expanded distally, much wider than the discoidal and rather closely reticulated, the anterior ulnar vein strongly approximated to radial; in female the anterior ulnar vein sub-parallel or somewhat nearer the radial, the ulnar area wider than the discoidal, but the spurious longitudinal vein less developed than in *pelidna*. Apex of wings rarely with well-developed spurious veins.

Pasture Locust.

Orphulella speciosa (Scudder).

Plate 11, fig. 3–5; Plate 20, fig. 12–15.

Stenobothrus speciosus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 458 (1862).

Stenobothrus aequalis Scudder, *ibid.*, p. 459.

Stenobothrus bilineatus Scudder, *ibid.*, p. 460.

Stenobothrus maculipennis Fernald, Orth. N. E., p. 37, in part (1888).

Orphula aequalis Morse, Psyche, vol. 7, p. 409 (1896).

Orphulella speciosa Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 80 (1911).

Measurements.

	Total	Tegmina	Teg. cf. H. f.	Hind femora	Antenna
Male	13–18.5	10–13.3	−1.5– +2	8.5–10	4.5–6.5
Female	15.5–21	9–16	−3 – +3	9.5–12	5–6.5 mm.

This species varies much in wing-length and almost incredibly in color and markings, being, in the latter respect, probably our most variable Locust.

In southern New England it is one of the most abundant and wide-spread of all our species, but owing to its small size and non-migratory habits has not attracted the attention given to the larger and seemingly more destructive species. While somewhat local, it is found nearly everywhere on dry, sandy, or

loamy soils, abundantly inland and sometimes in company with *O. pelidna* near the coast. It travels chiefly by leaping but readily takes wing on occasion, flying, however, but a few feet. Alert and active in the hot midsummer sunshine, it can often be captured in favorable places literally by hundreds with a few rapid strokes of the sweeping-net.

Adults begin to appear in the first week in July, are abundant in August and the first half of September, and become scarce in October. It is found in all of the New England States but is plentiful only in the southern half of the district. Some of the more northern records are: Grand Lake Stream, Orono, Norway, and Fryeburg, Me.; North Conway, N. H.; Woodstock and Mt. Ascutney, Vt. It is found on Nantucket, Martha's Vineyard, and other islands off the south coast. Long-winged examples occur in all parts of its New England range but seem to be more common in the north. While very scarce at Wellesley, Mass., they are not uncommon at Norway, Me., and Adams, Mass., and have been taken on the summit of Speckled Mt., Oxford Co., Me., 2800 ft., and Mt. Greylock, Mass., 3500 ft. (Hebard).

Spotted-winged Locust.

Orphulella pelidna (Burmeister).

Plate 20, fig. 6–11.

Gomphocerus pelidnus Burmeister, Handb. d. Ent., vol. 2, p. 650 (1838).
Stenobothrus maculipennis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 458, in part (1862).—Fernald, Orth. N. E., p. 37 (1888).
Orphula maculipennis Morse, Psyche, vol. 7, p. 408 (1896).
Orphulella pelidna Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 79 (1911).

Measurements.

	Total	Tegmina	Teg. pass Hind fem.	Hind femora	Antenna
Male	16.8–20.5	12.5–16.5	1–4.5	8.5–9.8	4.7–6.5
Female....	19 –26	13.5–20	0.5–3	10.5–12.5	5.5–7 mm.

The Spotted-winged Locust is a beautiful little species, relatively constant in its specific characters, but varying extraordinarily in color. It is active and alert, leaping well and also flying freely and well, sometimes to a distance of two or three rods, its larger size and longer wings making it more conspic-

uous in flight but also enabling it to escape more readily than *O. speciosa.*

It is widely distributed over southeastern New England, frequenting soils of sand or sandy loam, especially in Connecticut, Rhode Island, and southeastern Massachusetts. Adults begin to appear about the middle of July, being a week or two later than *O. speciosa,* and they may be found during the remainder of the season.

This species should be sought for in suitable localities in the Connecticut Valley in Massachusetts, and in southern Maine and New Hampshire. Its present known northern limit is Essex County, Mass. It is rare at Wellesley, Mass., but common in northeastern Connecticut.

Salt-marsh Locust.

Orphulella olivacea (Morse).

Plate 20, figs. 16, 17.

Stenobothrus olivaceus Morse, Psyche, vol. 6, p. 477 (1893).
Orphula olivacea Morse, Psyche, vol. 7, p. 411 (1896).
Orphulella olivacea Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 81 (1911).

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	19 –20.7	16.5–18.7	14–15	10 –10.5	6–7
Female	23.5–28	21 –25	17–21	12.5–14	6 mm.

This is the largest of our three species of Orphulella, but is much less likely to be met with owing to the fact that it is a halophile, in other words, a salt-lover, and lives only in the salt-marshes of the coast, where it is found from the southern shore of New England southward along a great extent of the seaboard of the South Atlantic and Gulf States.

It was first discovered at Stamford and Greenwich, Ct., and Walden has since recorded it from New Haven and Stratford in that State. In New England it is very local, often restricted to an area of but a few square rods, but sometimes exceedingly abundant in that place. The coloring of the living Locust, whether greenish or brownish, exactly matches the olivaceous tones of the tangled marsh vegetation. Beneath the stratum of plant life, which furnishes food, shelter, and support for the

insects, the ground is always saturated, completely overflowed by high tides, and frequently is riddled with the burrows of myriads of fiddler crabs, thus differing widely from the sandy upland soils frequented by its congeners, *O. speciosa* and *O. pelidna*.

Dates of capture range from August 11 to 28 but it probably could be found in the adult stage from about the first of August until October.

Sprinkled Locust.

Chloealtis conspersa Harris.

Figs. 81, 82; Plate 20, figs. 18, 19.

Chloealtis conspersa Harris, Report, p. 149 (1841); Treatise, 3d ed., p. 184 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 145 (1868); Rept. Ct. Bd. Agric. for 1872, p. 375 (1873).—Fernald, Orth. N. E., p. 36 (1888).—Morse, Psyche, vol. 7, p. 419 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 83 (1911).

Vertex bluntly triangular, wider than an eye, margins little elevated, foveolae absent or reduced to small pits, median carina feebly developed, in side view slightly descending, subangulate or rounding smoothly into the strongly retreating face. Antennae linear, flattened, slightly wider at base, once and a half or twice as long as head and pronotum together. Pronotum nearly flat above, carinae distinctly and about equally developed; front and hind margins nearly straight; sides uniformly slightly but regularly concave (♂), or distinctly a little narrowed just behind middle of prozone and tapering in both directions (♂, ♀); prozone distinctly longer than metazone, lateral lobes as deep as long. Tegmina abbreviated, in female covering one-half of abdomen, in male falling just short of tip of it. Examples are rarely found with fully developed tegmina and wings. Hind

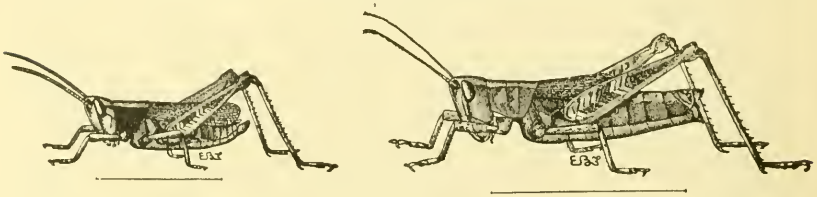

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Fig. 81.—Sprinkled Locust, *Chloealtis conspersa*. Male. (After Lugger.)
Fig. 82.—Same. Female. (After Lugger.)

femora long and rather slender, but powerful. Subgenital plate of male short, conical, blunt. Ovipositor characteristic, very short, little exposed, with sharp tips and strong lateral teeth.

Color: usually pale dead-leaf brown above, sometimes spotted with darker, sometimes dark brown flecked with fuscous. Lateral lobes of pronotum in male shining black, their upper posterior corner in female, and the sides of base of abdomen and inner side of hind femora dusky to black. Hind femora varying from nearly uniform brown to a conspicuously mottled pattern, with white spots at one-fifth and one-half their length from base, bounded indistinctly by fuscous. Hind tibiae red, paler at base, with black spines. Abdomen beneath often more or less strongly orange posteriorly.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	15–19	7.7–12	10.7–13	10–11
Female	20–28	7–10	11.6–16	10–12 mm.

Long-winged form.

	Total	Tegmina		Tegmina pass hind femora
		Long	Wide	
Male	27	19.5	4.7	2
Female	28	20	4.8	3 mm.

The Sprinkled Locust is readily recognized, none of our other species resembling it closely. The lack of foveolae on the vertex, the shining black sides of the pronotum of the male, and the peculiar form of ovipositor of the female are distinguishing characters always available, even though the male differs so much from the female that it may readily be taken for a different species, a mistake which has been made by more than one entomologist.

While not abundant, it is locally common in suitable situations, showing a preference for bushy pastures and the edges of woodlands, particularly on dry soil, and wherever old stumps and fragments of decaying wood are accessible for its eggs. Its habits of oviposition have been observed on numerous occasions. The eggs are laid in the soft wood of fence-rails, stumps, logs, or scattered blocks, in holes excavated by the rasp-like ovipositor valves, which are especially fitted for this purpose. The hole is about an eighth of an inch in diameter, usually at first nearly

perpendicular to the surface and the grain of the wood, then turns abruptly and runs parallel with the grain at about three-eighths of an inch from the surface, the entire length being an inch or more. The eggs to the number of from ten to fourteen are laid in the deeper part of the hole which is then closed by a gummy substance. "When a good piece of wood is discovered, the nests are crowded thickly together; and a stick less than two inches in diameter and five inches in length contained thirteen completed nests" (Scudder). But many attempts are often made in unsuitable wood, resulting in failure to penetrate. Fuller descriptions of observations will be found in Smith's "Orthoptera of Maine" and "Orthoptera of Connecticut," Scudder's "Distribution of Insects in New Hampshire," and Blatchley's "Orthoptera of Indiana."

The females are relatively sluggish and are easily captured, moving of necessity, owing to the brevity of their wings, only by crawling and leaping; the males are much more alert and active.

It matures early in the season, in late June and early July, and scattering females survive till late in the autumn. It probably inhabits the whole of New England, and extends outside our borders to Alabama, Arkansas, etc.

Meadow Locust.

Chorthippus curtipennis (Harris).

Plate 20, fig. 20.

Locusta curtipennis Harris, Cat. Ins. Mass., p. 56 (1835).
Locusta (Chloealtis) curtipennis Harris, Treatise, 3d ed., p. 184 (1862).
Stenobothrus curtipennis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 456 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 147 (1868). —Fernald, Orth. N. E., p. 37 (1888).—Morse, Psyche, vol. 7, p. 420 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 83 (1911).
Stenobothrus longipennis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 457 (1862).

Antennae slightly flattened, once and a half (♀) or twice (♂) as long as head and pronotum. Vertex short, triangular, nearly horizontal, but little narrowed by the eyes; foveolae conspicuous. Disk of pronotum nearly flat. Lateral and median carinae equally developed, the lateral carinae convergent to middle of prozone, evenly divergent to shoulders; prozone usu-

ally a little longer than the metazone. Hind margin of disk very obtusely angulate. Tegmina rather narrow at base; broader distally, widest at distal third, especially in male, by a dilation of the scapular area; tapering to apex in male, broad and rounded in female. In the short-winged female the tegmina are narrow throughout. Hind femora long and rather slender, with an exceptionally long row of fine, closely set teeth forming the stridulating rasp. Subgenital plate of male short, rounded, bluntly conical. Ovipositor valves rather slender, sharp-tipped, moderately exserted.

Measurements.

	Total	Body	Hind femora	Tegmina	Antenna
Male	14 –22	13.5 –15.5	10.5–11.8	8.5 –15	8.5–10.5
Female	12.4–23	15 –24.5	11.5–14	7 –16.5	6.5– 8 mm.

	Tegmina cf. Hind femora
Male	–3–+3
Female	–7–+2

This species is very variable in color, markings, and wing development, but is readily recognized by the linear foveolae distinctly visible from above. The wings are probably always capable of being expanded sufficiently to serve as parachutes at least, being in nearly every case almost as long as the tegmina. While the larger proportion of individuals falls into a long- or a short-winged series, there is no sharp line of demarcation between the two, intermediate examples being not uncommon. Short-winged individuals are usually much more numerous.

The three most striking color varieties are the following: (1) dorsal half of sides of pronotum and cheeks fuscous, darkest above; (2) sides of pronotum light gray, crossed half-way down by a broad, irregular fuscous band; cheeks somewhat infuscated above and below a pale band at level of lower margin of eye; (3) face, sides of head and body, green. Each of these phases may be either light gray, yellowish, reddish, or fuscous above, or of intermediate tint, and either long- or short-winged. The hind tibiae and hind femora are usually either yellowish or reddish, but the femora are sometimes bright green on the dorsal face.

This insect is a sprightly, wide-awake little "hopper" of no mean ability, and also freely makes use of its wings when needful. It

is an artful dodger, and adept in all kinds of tumbling and vaulting. While usually common wherever there is a thick and succulent growth of herbage, it is especially plentiful in the tall growth of grasses and sedges in moist meadows and salt-marshes, along ditches, brooksides, etc. In favorable stations it is a not uncommon experience to find, after a few sweeps, a couple of dozen examples in the net; and the total population of such an area is almost beyond computation or belief.

The season during which adults may be found is probably the longest of any of our Locusts: specimens are recorded from June 24 to November 17. It is also one of the most thoroughly distributed of our species in the field, and can probably be found in every township in New England where there is a swampy area of some extent.

THE SEDGE-LOCUSTS, MECOSTETHUS.

Our three species of Sedge-locusts, referred variously at times to *Arcyptera*, *Stetheophyma*, and *Mecostethus*, resemble each other closely and have by some been thought to represent but one. There can be no question, however, on the part of those who have studied examples of all three that Scudder discriminated them with perfect accuracy, and that they are entirely distinct.

These Locusts are above the medium size, and present an unusually smooth, shining surface correlated with their life in moist places.

The vertex is prominent, a little descending. The mid-carina of the pronotum is well developed, narrow and sharp; the lateral carinae much less distinct. The prosternum projects into a low, pyramidal tubercle. The tegmina are long, and rather wide apically, with prominent intercalary vein and venules, toothed or roughened in the male. The subgenital plate of the male is conical and acutely tipped; and the valves of the ovipositor of the female are much exposed.

Striped Sedge-locust.

Mecostethus lineatus (Scudder).

Plate 11, fig. 9; Plate 20, fig. 21–23.

Arcyptera lineata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 462 (1862).
Stetheophyma lineata Fernald, Orth. N. E., p. 38 (1888).

Mecostethus lineatus Morse, Psyche, vol. 7, p. 443 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 85 (1911).

Vertex with lateral margins decidedly elevated and mid-carina distinct. Lateral foveolae of male short, triangular, of female shallow and nearly obsolete. Pronotum with hind margin decidedly angulate or convex, the lateral carinae low and dull and cut by two sulci. Surface of pronotum punctate. Subgenital plate of male elongate-conical, two and one-half times as long as deep, its ventral outline concave. Ovipositor valves rather slender and smooth, tips not extremely sharp.

Color: male, dark brown above, the sides of the head and body, especially in front, varying from yellowish green to greenish yellow; beneath, bright yellow. Basal half or two-thirds of hind femora cherry red beneath; this is succeeded by bands of fuscous or dark brown and yellow, with the knees black. Hind tibiae for the most part straw yellow, black at tip and base, and usually more or less ringed or clouded with fuscous near base. Tegmina dark brown, sometimes purplish brown, a conspicuous white streak on basal half of costal area, fading out distally. This is sometimes continued forward as a narrow line along the lateral carinae, broadening on head as a pale area behind eye. Female usually much darker than the male, sometimes with much Indian red, claret brown, or even maroon on the sides of the head and body. An irregular pale area sometimes extends from the prozone downward and forward on the cheeks. The tegmina are nearly transparent except at the base, the veins and venules dark brown; wings transparent, yellowish on hinder half, faintly washed with brown on apex and at distal third of costal margin.

Measurements.

	Total	Body	Tegmina	Tegmina, average		Hind femora	Antenna
				Length	Width		
Male	28–32	23–27	21–26.5	23.5	4.6	14.5–18	11–12
Female	35–41.5	34–38	26–31.5	29.5	5.5	18 –21	10–11.5 mm.

Besides the characters already stated, this species differs from our other two in having longer and narrower tegmina whose dorsal portion is not so evidently angulate with the lateral at the junction and does not differ from it markedly in tint.

This elegantly formed, brilliantly colored Locust is our best known species of the genus and is very widely distributed, prob-

ably occurring locally throughout New England. It is most common, often abundant, in wet, sedgy meadows along brooks and rivers, and in swamps and bogs where water stands upon the ground for days at a time. This open habitat is its preferred and characteristic environment whether at sea-level or above timber-line on the sedgy plateau of Mt. Katahdin, Me.; but, as should be expected, it also occurs in swamps among low trees and bushes, which are simply open areas on which the forest is encroaching.

It is a shy and alert species, the males being especially active and wide-awake, often starting up at a distance of several yards. They take wing suddenly and rise rapidly into a swift, powerful, and sustained flight which is often prolonged for one or two hundred feet in a straight, slightly ascending, then gradually descending course. The females are more sluggish, much more reluctant to rise, and hardly one is observed to a score or two of males. Sometimes, alarmed by the footsteps of an intruder, they climb up on the grass stems and may be seen previous to their taking flight.

This Locust has been taken from extreme northern and eastern Maine to southern Connecticut, and at various altitudes up to 4700 feet on Mt. Katahdin. Outside of New England it has been recorded from New Jersey, Indiana, Illinois, Minnesota, and eastern Nebraska.

Adults may be looked for from the middle of July during the rest of the season, captures having been made from July 21 to October 6.

Northern Sedge-locust.

Mecostethus gracilis (Scudder).

Plate 20, fig. 24.

Arcyptera gracilis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 463 (1862).
Mecostethus gracilis Morse, Psyche, vol. 7, p. 444 (1896).

Vertex with lateral margins less elevated than in *M. lineatus;* lateral foveolae nearly obsolete in both sexes. Pronotum with hind margin but little produced. Subgenital plate of male less prolonged than in *M. lineatus*, about twice as long as deep. Ovipositor with base of valves broader, much like *M. platypterus,*

but the outer edges of the upper valves even more prominently toothed.

Measurements.

	Total	Tegmina	Tegmina, average Length	Tegmina, average Width	Hind femora	Antenna
Male . . .	22.5–28	16.5–21	21.5	5.5	12 –14	9 –10
Female	24 –31.6	17 –23.5	23	5	14.5–16	8.5–9.5 mm.

This is a duller-colored insect than its striped relative, the prevailing hue being a dead-leaf brown, somewhat yellowish, distinctly paler above and darker on the sides. The brilliant red of the under side of the hind thighs extends fully three-fourths of their length, covering that part which is clouded or ringed with fuscous in *M. lineatus*.

It may be readily distinguished from *M. lineatus*, which it most resembles in the form of the pronotum, by the characters stated and by the more compressed form of the body, especially of the head and prozone, the smaller size, and the broader tegmina, which have the internal (dorsal) border noticeably expanded.

This is a not uncommon Locust in the northern States, even plentiful locally, but rather shy, taking readily to wing and flying two or three rods. Its flight is straight and it drops rather suddenly into the grass. On the summit of Mt. Greylock, Mass., where most of my specimens were secured, it was somewhat difficult to distinguish from *Camnula pellucida* when on the wing. Both sexes fly well but the male is the more active, and seems three or four times as plentiful. It lives in wet, sedgy meadows and bushy swamps and on the tops of mountains even above timber-line. On Mt. Greylock it was formerly common in the low bushes and grass at the extreme summit; on Mt. Washington, N. H., in the extensive sedgy area called the "Cow-pasture" or "Semidea plateau." At Whitneyville, Me., Alstead, N. H., and Woodstock, Vt., I have taken it in company with *M. lineatus*.

It is known also from Orono, Jackman (F. P. Briggs), Norway, and Great Cranberry Id. (Hebard), Me.; Jefferson, N. H.; Montgomery and Newport, Vt. Adults have been taken from July 12 to September 6.

Its stridulation is the loudest produced by any of our Acridinae and can be heard for two or three rods. A description and nota-

tion of its 'song' will be found in Scudder's "Distribution of Insects in New Hampshire" and also in the 23d Report of the Entomological Society of Ontario (1893, p. 76).

Broad-winged Sedge-locust.

Mecostethus platypterus (Scudder).

Plate 20, fig. 25–27.

Arcyptera platyptera Scudder, Boston Journ. Nat. Hist., vol. 7, p. 463 (1862).

Mecostethus platypterus Morse, Psyche, vol. 7, p. 445 (1896).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 85 (1911).

Vertex broad, blunt, full, with margins little elevated and mid-carina more prominent. Lateral foveolae absent or showing but as faint traces. Pronotum with hind margin little extended, prozone equal to metazone, lateral carinae parallel or very nearly so, continuous, faintly cut only by principal sulcus. Surface of disk of pronotum with minute longitudinal ridges. Prosternum less protuberant than in either of its congeners. Subgenital plate of male short, conical, about one and a half times its depth. Valves of ovipositor with the base stouter, the outer edges of the upper pair a little more prominently toothed and with somewhat sharper tips than in *M. lineatus*.

Measurements.

	Total	Tegmina	Tegmina Length	Tegmina Width	Hind femora	Antenna
Male.....	26.8–29	19–21	21	5	15 –16.5	11–12.5
Female.....	34 –40	24–25	24.5	4.8	17.6–20.6	10–11 mm.

The brownish of the coloration is of a somewhat darker tint (bister) on the sides of the pronotum and head, and deepens into fuscous below the lateral carinae of the pronotum and behind the eyes. The hind tibiae are not annulate and their spines are slenderer and dusky only at the tip or scarcely at all. The red of the hind femora is less intense and often replaced by yellowish. As in *M. gracilis*, the dorsal field of the tegmina is distinctly paler than the lateral field and meets it at a more distinct angle.

The parallel lateral carinae of the pronotum, the large head, wide vertex, and long antennae readily separate this species from *M. gracilis*, which otherwise it most resembles superficially.

This is one of the rare Locusts of our fauna. I have seen only about a score of specimens and of those the majority were taken from one spot in a sedgy swamp in Thompson, Ct., on the 4th and 25th of August. A. L. Babcock of Sherborn, Mass., who gathered a general collection of insects in the latter half of the last century, captured three specimens in that vicinity in his early collecting. "These are the only localities known to me though it will probably be found to occur over a wide area. At Thompson it is found in company with *lineatus* and is impossible to distinguish when flying, though its flight is somewhat less sustained and it is decidedly more difficult to flush. It is a less shy and active species than *lineatus*, and the female, while perfectly able to fly, is very sluggish,—the single one taken personally was secured while endeavoring to start specimens up out of the long sedge of a swamp, and being seen perched upon the grass was at once swept into the net." I can add nothing to these notes, written several years ago. It still remains a rarity, to be secured only by good fortune or the most persistent search.

Extralimital records are from Illinois, Iowa, and Minnesota, from the last in dense tamarack swamps.

THE BAND-WINGED LOCUSTS—OEDIPODINAE.

In the Band-winged Locusts the vertex of the head slopes downward anteriorly, and is rounded at its junction with the face, which is relatively vertical, contrasting in these particulars with the Acridinae. The eyes are small, the antennae filiform, and the prosternum unspined. The pronotum is often constricted at or in front of the principal sulcus, usually rugose or tuberculate, with strongly pronounced, often crest-like median carina, cut by one or two incisions in front of the middle, rarely entire; the lateral carinae are poorly developed, usually discontinuous. The metazone is longer and broader than the prozone, its hind margin produced, angulate. The tegmina and wings are always fully developed, large; the wings usually present a bright-colored disk bounded by a dark transverse band and a transparent, maculate, or dusky tip. The tegmina are usually densely reticulate except toward the tip, with a well-developed intercalary vein which is usually roughened for stridulating, at least in the male.

The systematic characters used in the classification of this subfamily are drawn chiefly from the modeling of the head and pronotum and from the venation of the wings. The terminal segments of the abdomen, so important in the Melanopli, are valueless in this group for purposes of classification.

These Locusts are among the most alert, active, and attractive members of the order. For the most part they live among and enliven the relatively waste places of the earth, inhabiting not only the barren fields and pastures but also patches of bare soil in all spots scantily clad with vegetation—whether fields, roadsides, or vacant lots,—even the outcropping ledges of rocky hills and the shifting sands of the seashore and inland dunes.

To this group belong all of the New England Locusts having brightly colored wings, a fact which, taken in connection with their medium or large size, causes them to be relatively conspicuous objects in flight. Not all of our species are thus decorated, but by far the larger number—twelve out of fifteen—the remaining three having the wings either pellucid or faintly clouded. It is worthy of notice in this connection that the latter greatly outnumber in point of individuals their more conspicuous relatives and that they frequent fields with an abundance of grass rather than places where the herbage is sparse, and seemingly more attractive to many of the others. They are also much less shy and active than the bright-winged species, which are the wariest of all our Locusts.

The wing color may be mainly black, yellow, or red, yellow tints predominating. It is in no sense protective and has no relation to the environment, but is probably of value in the mating of the sexes as a guiding or recognition color signal. It may vary in the same species without regard to sex. It varies much with age, newly matured examples being relatively pale. In some species (*e.g.*, the Sand Locust) different individuals show all shades of color from dull white through yellow and orange to vermilion; a variety of coloring may be found in the same locality or red examples may be lacking. In the Coral-winged Locust, whose wings are normally red, yellow-winged examples rarely occur. The same species sometimes varies in wing color geographically, in certain parts of its range the majority of examples being red-winged, in others yellow or orange.

The Oedipodinae are notable not only for their gaudily colored wings, but quite as much for the rattling noise which the males of many species produce in flight. The female also, in some cases, makes it in less degree. Sounds are produced not only while flying, but also when at rest, as in the Acridinae, by rubbing the hind thighs against the wing-covers, the intercalary vein of which is in most cases toothed or roughened.

Key to the Species of New England Oedipodinae.

(See Plate 21.)

A. Wings black with a pale border
Carolina Locust, *Dissosteira carolina*, p. 465.

AA. Wings not black.

B. Disk of wings nearly or quite transparent, not bounded by a distinct blackish band.

C. Prozone roof-shaped, the lateral carinae absent, the front margin angulate. Hind femora without dusky bands on outer face. Intercalary vein of tegmina sinuous, approximated distally to radial vein. Discoidal area of tegmina much narrower than distal end of ulnar area. Wings usually faintly clouded with dusky in front of middle of hind margin.
Green-striped Locust, *Chortophaga viridifasciata*, p. 455.

CC. Prozone with disk relatively flat, the lateral carinae conspicuous. Discoidal area of tegmina as wide as widest part of ulnar area.

D. Median carina of pronotum high; disk of prozone nearly as wide and long as metazone. Intercalary vein of tegmina straight, nearer ulnar than radial vein for its entire length. Wings faintly clouded with dusky at tip, the disk faintly yellowish.
Dusky Locust, *Encoptolophus sordidus*, p. 458.

DD. Median carina of pronotum low; disk of metazone much wider and longer than prozone. Intercalary vein of tegmina sinuous, approximated to radial vein distally. Wings with dusky venules but transparent except for very faint tinge of dusky at tip.....Clear-winged Locust, *Camnula pellucida*, p. 460.

BB. Disk of wings opaque, colored (white, yellow, orange, red), plainly bounded by a black band.

E. Median carina of pronotum entire, not incised.[1] Scutellum of vertex with a distinct, usually deep, transverse curved impression. Dark brown species with very slender antennae, densely reticulate tegmina, and deep-yellow wings.

[1] The great majority of specimens fall readily into one or the other of these series. Rarely examples of the Sand Locust and the Marbled Locust present a profile which will leave the novice in doubt.

F. Median carina of pronotum high, arched, compressed, crest-like. Hind margin of pronotum acute-angled. Facial costa with sides parallel. Dusky band of wing widened near front margin, extending one-fourth to one-third the distance to the base of wing...Autumn Yellow-winged Locust, *Arphia xanthoptera*, p. 451.

FF. Median carina of pronotum relatively low, not cristate. Hind margin of pronotum right-angled in male, a little obtuse in female. Facial costa with sides converging at meeting with vertex. Dusky wing-band near front margin extending two-thirds the distance to base.

Spring Yellow-winged Locust, *Arphia sulphurea*, p. 453.

EE. Carina of pronotum cut once, by principal sulcus. See also EEE.[1]

G. Robust species with antennae not or but little exceeding head and pronotum. Dusky wing-band anteriorly extending nearly to base of wing. Hind tibiae dull yellow.

H. Prozone distinctly shorter than metazone. Wings usually red. Vertex prominent in side view. Hind process of pronotum acute or right-angled. Antennae short, only about equal to head and pronotum.

Coral-winged Locust, *Pardalophora apiculata*, p. 462.

HH. Prozone and metazone of equal length; the lateral carinae not cut by principal sulcus. Vertex smoothly convex in side view. Hind margin of pronotum obtuse-angled. Wings usually yellow, sometimes orange or red. Antennae longer.

Wrinkled Locust, *Hippiscus rugosus*, p. 464.

GG. Slenderer species, the body more or less compressed. Antennae much longer than head and pronotum (usually two or three times). Dusky wing-band anteriorly but little prolonged toward base of wing. Hind tibiae red, or annulate with fuscous, red, and pale.

I. Hind tibiae ringed with fuscous and red, with pale band near base.

J. Larger, the ♀ over 30 mm., ♂ over 26 mm. Median carina of pronotum equally developed throughout, rather high, reaching level of top of head. Vertex projecting the width of an eye. Front margin of pronotum distinctly angulate and body compressed.

Boll's Waste-land Locust, *Spharagemon bolli*, p. 469.

JJ. Smaller, the ♀ less than 30 mm., the ♂ less than 25 mm. Carina of pronotum low, depressed below level of top of head. Eyes prominent. Vertex short, less projecting.

Marbled Locust, *Scirtetica marmorata*, p. 472.

II. Hind tibiae without dusky annulations. Median carina of prozone unequally developed, the hind part of disk of prozone elevated, rising broadly on the carina.

K. Carina high, arched on both prozone and metazone; the cleft

[1] See footnote on previous page.

oblique and closed, the front lobe often overlapping the rear. Hind margin acute-angled, its sides concave. Hind tibiae red, sometimes paler at base.
Scudder's Waste-land Locust,
Spharagemon collare scudderi, p. 467.

KK. Carina rather low, usually sinuate on prozone in side view; the cleft nearly or quite vertical, open. Hind margin about right-angled, its sides straight. Hind tibiae distinctly pale-ringed next base.
Ledge Locust, *Spharagemon saxatile*, p. 470.

EEE. Carina of pronotum with two distinct notches, the anterior often less marked than the posterior.

L. Transverse dusky band of wings broad throughout, at least as broad as the width of a tegmen, continuous. Anterior notch of pronotum often shallow. Tegmen narrow, many of the cellules in the hinder part of distal half two to four times as long as wide. Pronotum much constricted. Hind tibiae annulate with fuscous and yellowish white.....Sand Locust, *Psinidia fenestralis*, p. 474.

LL. Transverse dusky wing-band narrow, usually discontinuous just behind the anterior submarginal widening. Carina of pronotum very low, the notches almost equally distinct.

M. Hind tibiae entirely pale. Radial veins of wings not enlarged. General color pale brown or buff, and white. Sides of pronotum usually distinctly angulate at meeting of lower and hind margins. A seashore, sand-dwelling species.
Seaside Locust, *Trimerotropis maritima*, p. 476.

MM. Hind tibiae dusky at tip and usually also at two-fifths of the distance from base to tip, elsewhere yellowish white. Radial area of wing expanded posteriorly and two or three radial veins distinctly enlarged. General color dark gray or black. A boreal, chiefly ledge-dwelling species.
Broad-winged Locust, *Circotettix verruculatus*, p. 478.

Autumn Yellow-winged Locust.

Arphia xanthoptera (Burmeister).

Plate 10, fig. 2; Plate 21, figs. 1, 2.

Oedipoda xanthoptera Burmeister, Handb. d. Ent., vol. 2, p. 643 (1838).—Scudder, Boston Journ. Nat. Hist., vol. 7, p. 469 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 372 (1873).

Locusta sulphurea Harris, Treatise, 3d ed., p. 177, in part (1862).

Arphia xanthoptera Fernald, Orth. N. E., p. 39 (1888).—Morse, Psyche, vol. 7, p. 50 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 90 (1911).

Body rather strongly compressed. Antennae very slender, about equal to the pronotum in the female; in the male longer,

brown, darkened toward the end, which is very slightly enlarged. Scutellum of the vertex blunt anteriorly, nearly as broad as long, the lateral carinae often continued backward and more convergent on the occiput than in *A. sulphurea*. Facial costa broad throughout, scarcely narrowed at union with vertex. Pronotum with the carina high, arched, equalling one-third to one-half the depth of the lateral lobes, the disk somewhat tectiform; front and hind margins strongly produced, with sides excavate and the hind margin acute-angled.

General color blackish brown (♂) or tawny brown (♀) above, sometimes much paler or yellowish brown on the cheeks and outer face of hind femora; beneath black. Tegmina often mottled with black or dusky. Wings with the basal half or more bright yellow, bounded distally by a broad black band about as wide as the wing-cover, which sends off a broad shoot near the front margin one-fifth to one-half the distance to the base of the wing; apex transparent, clouded with fuscous. Hind femora annulate with pale near the knees, which are black, and spotted or banded with pale on the inner side of base at the half. Hind tibiae dusky, paler beneath on the distal half, and annulate with pale at the basal fifth.

In the central States a variable proportion of the specimens captured have the disk of the wings a deep orange, but this coloration apparently does not occur in New England.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	30 –34	21–25	22.5–27	14.6–17.3	10–11
Female	34.5–40	28–32	26.5–30	17 –18.5	9–11.5 mm.

In sunny September days, when the tufted bunch-grass (*Andropogon*) unsheathes its feathery plumes and its stems begin to take on the deep Indian-red hue of maturity, when amethyst patches of the "fly-away" or purple wood-grass (*Eragrostis pectinacea*) enrich the fading fields, the Autumn Yellow-winged Locust adds its quota of color and sound to the pageant of autumn. With large and brightly colored wings and rattling flight it seldom fails to attract the attention and interest of the September stroller in sandy fields, where it enlivens the landscape even in this golden time of the year. On warm days, where it is numerous and active,

there is heard an almost continuous succession of purring flights as the handsome creatures seek out and pay court to their waiting mates. Not only while flying do they produce sounds, but I have seen and heard them stridulate while at rest by rasping the hind thighs against the tegmina (for details see Journ. N. Y. Ent. Soc., vol. 4, p. 16–20, 1896).

This is a shy species and flies readily and strongly, often to a distance of several rods, and its rattling crepitation is of greater volume than that of its spring-time congener, *A. sulphurea*. It is equally common, perhaps even more numerous locally, than the latter and frequents the same situations: old fields and bushy pastures on sandy soil. In the one it is often associated with the Collared or Scudder's Locust, in the other with Boll's Locust.

Adults have been taken from the last of July till November, in the Austral and warmer parts of the Transition zones of New England: in middle New Hampshire (Scudder); Andover, Belmont (Maynard), Dedham, Wellesley and vicinity, and Nantucket, Mass.; Wickford, R. I.; Thompson, South Kent, New Haven, Greenwich, and Stamford, Ct.

Spring Yellow-winged Locust.

Arphia sulphurea (Fabricius).

Plate 21, fig. 3.

Gryllus sulphureus Fabricius, Species Insectorum, vol. 1, p. 369 (1781).
Locusta sulphurea Harris, Treatise, 3d ed., p. 177, in part (1862).
Oedipoda sulphurea Scudder, Boston Journ. Nat. Hist., vol. 7, p. 470 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 372 (1873).
Arphia sulphurea Fernald, Orth. N. E., p. 39 (1888).—Morse, Psyche, vol. 7, p. 51 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 89 (1911).

Body only moderately compressed. Antennae slender, slightly and very gradually broadened on apical third. Facial costa strongly narrowed above at junction with vertex. Scutellum of vertex pointed anteriorly. Pronotum with the carina low, horizontal in the middle, one-fourth to one-third as high as depth of lateral lobes; anterior margin a little produced, arcuate; hind margin rectangular or a little obtuse.

General color yellowish to blackish brown, less often tawny

above; brown beneath. Tegmina usually more or less sprinkled with fuscous dots, sometimes noticeably pale along dorsal margin. Disk of wings deep yellow, bounded by a blackish cross-band which is sometimes as wide as, but usually narrower than a tegmen, and which sends off a subfrontal shoot two-thirds the distance to the base; apex transparent, more or less clouded. Hind femora nearly uniform brown, faintly fasciate externally, strongly fasciate internally. Hind tibiae dusky brown, blackish, or greenish black, annulate with pale near base, and in female pale on distal third.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	23–26.5	17–19	17.5–20	11 –12.5	6–7.5
Female	28–30	26–28	20.5–23	13.5–15.2	6–3.5 mm.

The two species of *Arphia* inhabiting New England were apparently confused by Harris, and sometimes are today by others, but due attention paid to the characters stated in the Key should enable anyone to distinguish between them readily.

The great majority of Orthoptera hatch from the egg in spring or early summer, feed upon the tender vegetation everywhere available at that time, grow rapidly, molt several times, attain maturity, lay their eggs and perish, running the whole gamut of their active existence in a single summer season. To this rule there are among the Band-winged Locusts three conspicuous exceptions: the Spring Yellow-winged Locust, the Coral-winged Locust, and the Green-striped Locust. These three hatch in midsummer from eggs laid the same season, become about half-grown by the time cold weather sets in, hibernate as nymphs among the vegetable débris of the fields, and mature in the spring, —in late April or early May.

The Spring Yellow-wing is very common and widely distributed, occurring nearly everywhere in dry pastures in spring and early summer, its rattling stridulation being one of the constant features of a ramble in such places at that season. Its flight, particularly that of the male, is less extended than that of *A. xanthoptera*, being often limited to a few feet, but sometimes continued for three or four rods; its course is frequently circling, with an abrupt curve and a sudden drop into the grass and bushes at the end. "The male, when disturbed, moves in short, jerky

flights, sounding its cymbals while in the air, at every turn" (Blatchley). Adults begin to appear early in May, are common in June and July, and are occasionally seen as late as early September. It is probably found throughout New England, at least in all but the extreme boreal parts, having been taken at Norway and Deering, Me.; Berlin Falls and Hanover, N. H.; Brattleboro, Vt.; Wellesley, Winchendon, Woods Hole, and Martha's Vineyard, Mass.; and in all quarters of Connecticut.

Green-striped Locust.

Chortophaga viridifasciata (DeGeer).

Plate 12, figs. 3, 4; Plate 21, figs. 4, 5.

Acrydium viridifasciatum DeGeer, Mém. des Ins., vol. 3, p. 498, pl. 42, fig. 6 (1773).

Locusta (*Tragocephala*) *viridifasciata* Harris, Treatise, 3d ed., p. 181 (1862).

Locusta (*Tragocephala*) *infuscata* Harris, *ibid.*, p. 182.

Locusta (*Tragocephala*) *radiata* Harris, *ibid.*, p. 183.

Tragocephala infuscata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 461 (1862).

Tragocephala viridifasciata Scudder, *ibid.*—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 148 (1868); Rept. Ct. Bd. Agric. for 1872, p. 374 (1873).

Chortophaga viridifasciata Fernald, Orth. N. E., p. 40 (1888).—Morse, Psyche, vol. 7, p. 65 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 90 (1911).

Body compressed. Head narrow; face strongly retreating, subangulate at vertex. Scutellum of vertex narrow, shallow, without carinae.

Pronotum rather smooth, slightly rugose on prozone which is tectiform; metazone flat above; lateral carinae indistinct except near principal sulcus; median carina sharp, continuous, evenly compressed, incised but not notched by principal sulcus well in front of center. Front margin angulate, hind margin produced, acute-angulate, the apex well rounded.

Tegmina rather narrow, the intercalary vein sinuous, near ulnar at base, approaching radial distally. Wings rather narrow, transparent, faintly clouded with yellowish at base and with dusky on apical half, sometimes more deeply clouded with fuscous in front of middle of posterior margin, and frequently heavily infuscated along the veins and with an elongate fuscous spot on the third quarter of the costal margin, especially in the male.

Color: the female is usually grass-green above and on the sides of the head, pronotum, hind femora, and costal half of tegmina; the posterior (dorsal) half of the tegmina brown or gray. Some, however, are wholly brown of various shades ranging from pale yellowish almost to vandyke. The male is usually brown, but occasionally presents the green coloration of the female. Brown individuals taken early in the season are grayer in tone than those taken later, the brown deepening and becoming more yellowish with age. Rarely, the green is wholly or largely replaced on the head, pronotum, and hind femora by pink or reddish purple. The hind tibiae differ much in color, being variously tinted with brown, blue, pink, or purple, without regard to sex, often with a pale ring below the knees.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	21.5–26	17–20	16.8–20	10.5–12.5	6–8
Female	26 –33	22–32	18.6–25	13 –15.5	6–8 mm.

Owing to its retreating face, this Locust is not infrequently mistaken for an Acridine (Tryxaline) by the inexperienced, a fact not to be wondered at when it is considered that for a long time it was assigned to that subfamily by systematists, and especially when this character is considered in conjunction with its coloration, dichromatism, and preference for a relatively moist and verdurous environment.

It is our only species of the subfamily that is markedly dichromatic, presenting two distinct types of coloration: one entirely brown, the other largely green but with a small amount of brown on the tegmina. These two forms have been distinguished by the names *virginiana* for the green and *infuscata* for the brown, applied to them by Fabricius and Harris respectively, but they have no systematic significance and may be ignored. Specimens are occasionally found which can scarcely be referred properly to either form, the color being a mixture.

This dichromatism is largely characteristic of sex, most of the females being green, most of the males brown. Thus of three hundred specimens collected by the writer only 18 per cent of females were brown, of males 10 per cent were green. These

proportions are doubtless greater than exist in the field, since the collector naturally retains more of the rarer form. The proportion appears to vary geographically, since in some districts green males are almost unknown.

This, the most abundant of our springtime Locusts, is rather generally distributed but is found most plentifully in old, grassy mowing-fields and pastures, in both the drier and the moister portions, and though not partial to actually wet soils, seems to be equally at home in either.

It takes wing readily, but its flight is short, seldom over a rod or two in length. The male often flies in a circling course, and frequently stridulates, producing a fine, sharp crepitation; the female flies farther and in a more direct line.

The season during which adults may be found is the longest for any New England species of the group. They begin to appear in April, usually in the third week in the vicinity of Boston, are abundant in May and June, common in July, scarce in August, and occur rarely in September, October, and November. Owing to this fact, the species has been reported as double-brooded, but this is quite improbable in New England. Three females, taken in Massachusetts on November 8 and 17, had wings in unworn condition and had probably gained them that season through accelerated development.

The young may be readily found in the latter part of August and during the remainder of the season in the haunts of the adult. On mild sunny days in winter when the ground is bare they may be met with along the edges of woodlands on southward-facing slopes and in sheltered nooks. Here, in company with the young of the Coral-winged and Spring Yellow-winged Locusts they may be found hopping actively about on the approach of the stroller, pattering like hailstones on the dry leaves under foot. I have found them thus in midwinter within a yard of a long drift of unmelted snow.

This Locust doubtless inhabits the whole of New England. It has been recorded from every State and some of the off-shore islands. It is also widely distributed over the continent as a whole.

Clouded Locust; Dusky Locust; Dingy Locust.

Encoptolophus sordidus (Burmeister).

Fig. 83; Plate 21, fig. 6.

Oedipoda sordida Burmeister, Handb. d. Ent., vol. 2, p. 643 (1838).—Scudder, Boston Journ. Nat. Hist., vol. 7, p. 473 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 373 (1873).

Locusta nebulosa Harris, Treatise, 3d ed., p. 181 (1862).

Encoptolophus sordidus Fernald, Orth. N. E., p. 41 (1888).—Morse, Psyche, vol. 7, p. 66 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 92 (1911).

Body compressed. Head large, round, and full; scutellum of vertex broad, triangular; facial costa narrowed at vertex, sulcate throughout in male, above ocellus in female. Pronotum with disk rather flat, mid-carina sharp but not very high, cut by principal sulcus but little in front of middle; lateral carinae continuous; front margin convex, hind margin obtuse-angulate, apex rounded; lateral lobes but little deeper than wide, the lower margin strongly sinuous. Tegmina short, but little exceeding the hind knees, about one and one-third times as long as the hind femora; intercalary vein straight, nearer ulnar than radial throughout its course.

Color: dull brown or gray, heavily marked with blackish, often with a pallid X-mark on the pronotum. Tegmina strongly fasciate with fuscous. A velvety black triangular spot on upper side of hind femora on the second of a series of four transverse bands, the two basal of which are united more or less completely on the inner and under side. Hind tibiae dark brown or blackish, often more or less bluish, with strong black spines and a pale annulus below the knees. Wings transparent, clouded with yellowish at base and dusky on apical half, deepening toward tip.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male.....	21–28.5	19–21.5	16 –19.5	11–12	8–9
Female.....	28–32.5	24–35	20.5–34	14–15.5	8–9 mm.

This Locust is readily recognized from its superficial appearance, no other of our species resembling it in coloration or pattern. The variety of colors which it wears is very limited, the ground

tint being either a dull rusty, yellowish, or smoky brown, with markings of fuscous or black. In life a grayer tone prevails than is shown by cabinet specimens.

Unobtrusive as a clod of the earth itself, there is nothing spectacular about either the person or career of the Dusky, or Dingy Locust. Tinted like the soil, a lump of animated dust, this plebeian creature spends its humble life literally next to the ground in weedy fields, borders of tilled lands, and waste spots not too densely clothed with vegetation. Here it disports itself in numbers in late summer and autumn, an unnoticed element in the hordes of Grasshoppers that characterize the season.

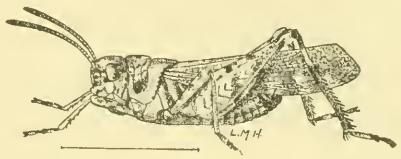

Fig. 83.—Dusky Locust, *Encoptolophus sordidus*. Male. (After Lugger.)

Dull-colored as it is, however, it is not unattractive in its modest dress of brown or gray marked with velvety black, a garb which renders it nearly invisible to the keen-eyed quail and meadowlark, ever on the alert for juicy morsels, and even to the fox himself, who does not disdain Grasshoppers in the absence of larger game. And it is often abundant in its haunts simply by reason of its obscurity.

In the warmth of mid-day it is active, flying freely though not far, rarely more than a rod or two, and the dull rattling and buzzing of its wings and those of its comrades form an almost incessant accompaniment to the footsteps of the stroller in the fields on sunny days.

Years ago I recorded (Journ. N. Y. Ent. Soc., vol. 4, p. 19, 1896) two modes of stridulation practiced by it while on the ground, in which the hind femora were the chief instruments employed; but the noise produced at this time is so very faint as to be scarcely noticeable unless the performer is directly under one's eye and ear.

Blatchley speaks of its note in flight as "a harsh droning or buzzing sound, somewhat resembling that of a bumblebee, but louder. It is begun after the insect has risen three or four feet above the ground, and is continued until it begins to descend, being kept up continuously while it is flying horizontally. The

females usually leap for the first two or three times they are disturbed, but if flushed a number of times they use the wings in endeavoring to escape."

It is one of the late-maturing species, first appearing in the winged state in late July or about the first of August and flying until the frosts and snow of November put an end to its existence. While it inhabits all of the New England States, it is probably absent from their more boreal portions and becomes really abundant only in the warmer districts. It is known from Orono, Norway, Fryeburg, and Deering, Me.; Jackson, Hanover, and Kingston, N. H.; Brattleboro, Vt.; and many localities in Connecticut and Massachusetts, including Edgartown on Martha's Vineyard.

Clear-winged Locust.

Camnula pellucida (Scudder).

Fig. 84; Plate 21, figs. 7, 8.

Oedipoda pellucida Scudder, Boston Journ. Nat. Hist., vol. 7, p. 472 (1862). —Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 373 (1873).—Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 378 (1874).

Camnula pellucida Fernald, Orth. N. E., p. 41 (1888).—Morse, Psyche, vol. 7, p. 80 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 92 (1911).

Body small for an Oedipodine, a little compressed. Head of moderate size, face somewhat retreating, facial costa rather prominent above, scutellum of vertex moderately deep. Disk of pronotum truncate anteriorly, obtuse-angled behind, flat, the lateral carinae continuous, nearly straight, the sulci shallow. Median carina low, keel-like, slightly arched on prozone, horizontal on metazone.

Color: in general, pale buffy white or dead-grass color, varied with dark brown or fuscous above and on sides. Wings transparent with smoky veins.

Head pale, darker above, a triangular fuscous spot behind eye and a band running forward from lateral ocelli to facial costa. Pronotum brown above, sometimes paler on disk along lateral carinae, the prozone chiefly black from lateral carinae nearly to lower margin; sides of metazone pale. A collared form has been noted in Minnesota.

Tegmina conspicuously pale along dorso-lateral angle, the dorsal field dark brown or fuscous, the lateral field with numerous irregular brownish fuscous blotches which vary much in pattern and intensity. Hind femora obliquely fasciate with fuscous; hind tibiae dull buffy, often infuscated distally and more or less clouded at basal third.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	20.5–24.5	17–21	15.5–18.5	9.5–12.3	7–9
Female	22 –30	21–28	19 –23.5	11 –14.7	6–8.5 mm.

In the markings of the tegmina, form, and color (excepting the wings) *C. pellucida* looks like a diminutive *Pardalophora* (*Hippiscus*), to which genus *Camnula* is closely related. It varies

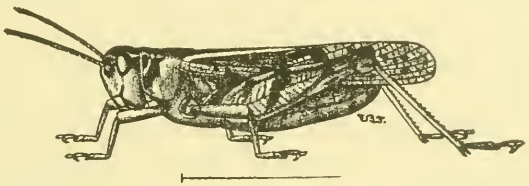

Fig. 84.—Clear-winged Locust, *Camnula pellucida*. Male. (After Lugger.)

much in size and tegminal markings but cannot be mistaken except by downright carelessness for any other species inhabiting New England.

It is found practically throughout Maine, New Hampshire, and Vermont, from the seashore to the summits of the highest mountains, over the larger part of northern and western Massachusetts, and occurs locally in northern Connecticut, possibly also in northern Rhode Island. Some of the more southern points at which it has been taken are Gloucester and Boxford, Mass., Thompson, Colebrook (Walden), and South Kent, Ct. Almost or quite a boreal species in New England, for some reason not yet determined, it extends on the Pacific Coast far into the Austral zone, and I have taken it even at Yuma, Ariz., in an alfalfa field.

It is extremely common, even abundant locally, throughout the northern part of New England, being undoubtedly the most numerous in point of individuals of any of our Oedipodinae. It is found most plentifully in dry grassy pastures and other untilled lands, commonly on high grounds, where it begins to appear in

the adult state about July 1st. Its flight is silent or slightly rustling, usually low, short, and direct, resembling that of a large *Melanoplus;* when with the wind, however, it is occasionally prolonged for several rods in a straight line.

Economically, this is one of the most important Locusts of New England. Always plentiful in its haunts, it needs but a few favorable droughty years to enable it to multiply to such numbers as to make it a dangerous pest; and on several occasions it has done great damage locally in Minnesota and California. The dry hill-pastures of Vermont and New Hampshire are often overrun with swarms of this species in late summer and the aggregate damage must be large. Personally, I have never seen it so abundant in New England as I once saw it on the summit of Mary's Peak in the Coast Range of Oregon, where the gravelly soil formed of decomposing rock débris actually swarmed with the myriads crawling in all directions, mating and ovipositing by the million. Somes describes the egg-pods in Minnesota as "short, stout, considerably curved, and not firmly cemented, containing twenty to thirty eggs each, and placed just below the surface of the soil or in some cases even above the surface amid dead grass."

Coral-winged Locust.

Pardalophora apiculata (Harris).

Plate 10, fig. 6; Plate 21, figs. 9, 10.

Locusta apiculata Harris, in Hitchcock's Rept. Geol. Mass., 2d ed., p. 576, (1835).

Locusta corallina Harris, Treatise, 3d ed., p. 176 (1862).

Oedipoda phoenicoptera Scudder, Boston Journ. Nat. Hist., vol 7, p. 468 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 371 (1873).

Hippiscus tuberculatus Fernald, Orth. N. E., p. 42 (1888).—Morse, Psyche, vol. 7, p. 81 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 94 (1911).

Body of male a little compressed. Vertex prominent, subangulate with face, lateral carinae prominent, median carina of scutellum obsolete anteriorly, supplementary carinae usually absent. Antennae of male equal to head plus pronotum, of female shorter, rather stout and a little flattened. Metazone much longer than prozone, its hind margin rectangulate or a little

acute, disk tuberculate and granulate; prozone tuberculate but not rugose, convex. Lateral lobes as long as deep.

Pale brown or yellowish clay color, more or less infuscated above. Pronotum often bearing a pale X-mark on disk. Tegmina with dorsal field usually pale, more or less infuscated at base except on edge between it and lateral field. A pale streak on basal half of costal vein, interrupted by a dusky spot behind the marginal angulation; another on the intercalary vein, broadening to cover a large part of the distal discoidal field where it is maculate with dark brown, leaving the ulnar area immaculate dark brown or fuscous. Wing with disk bright coral-pink bordered by a narrow dark-brown band which reaches from anal angle to costal margin, usually discontinuous between anal and humeral fields and sending off a subfrontal shoot which reaches to the base; beyond this the wing is transparent with dusky veins and smoky tip in the male. Hind femora usually obliquely fasciate with dusky. Hind tibiae dull yellowish or pinkish, the spines tipped with black.

Yellow-winged examples of this species have been taken but are of very rare occurrence. Sometimes the head, pronotum, and hind femora, even in the half-grown nymph, are largely green.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	32–38	25–28	24–30	14 –16	10.5–12
Female	39–43	36–44	30–32	18.5–20.5	11.5–13.5 mm.

Ramblers in the fields of June are often stirred by the sight of flashing pink wings in rapid flight, which vanish suddenly, and the less observant or reflective ask the identity of a "beautiful pink-winged butterfly" which disappeared as mysteriously as it came. This is it. Its gaily colored wings make it a conspicuous object in flight, and it is very ready to take wing and goes to a considerable distance. The female is much less active than the male and seldom rises more than once, even when pursued. The flight of the male is often accompanied by a rapid rattle, louder than but similar to that of the Spring Yellow-winged Locust (*Arphia sulphurea*) with which it is commonly found associated. Its haunts are upland pastures, abandoned fields and unimproved lands, often partly overgrown with weeds and bushes, where it is found from the last week of April till mid-July, or even later.

The young, which are sometimes noticed as early as the latter part of August, are curious little, depressed, toad-like creatures of a purplish-leaden color, and may be found, under suitable conditions of weather, in the fall, winter, and early spring months in localities frequented by the adults.

The Coral-winged Locust probably occurs throughout New England, having been taken on the summits of Mt. Katahdin and Mt. Washington, on Nantucket Island, in southern Connecticut, and many intermediate localities; it is also widely distributed beyond our borders.

Wrinkled Locust.

Hippiscus rugosus (Scudder).

Plate 21, fig. 11.

Oedipoda rugosa Scudder, Boston Journ. Nat. Hist., vol. 7, p. 469 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868).

Hippiscus rugosus Fernald, Orth. N. E., p. 42 (1888).—Morse, Psyche, vol. 7, p. 81 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 95 (1911).

Head full, rounded, occiput very convex; vertex short, strongly declivent, smoothly rounded into face, its scutellum convex, divided into four parts by low carinae running outward and backward from middle of median carina. Prozone equal to metazone, strongly rugose; disk of metazone coarsely tuberculate, the hind process rectangulate or a little obtuse. Lateral lobes deeper than long, the hind angle very broadly rounded. In size this species is somewhat less than its congener, the Coral-wing.

Pale brown or clay color, the tegmina heavily and irregularly spotted with fuscous. Hind tibiae clay yellow, sometimes clouded near the middle with dusky. Disk of wings yellowish white, yellow, pinkish, or vermilion, covering one-half to four-sevenths of the wing, bounded by a narrow fuscous band from which near the costal margin extends a shoot one-half or two-thirds the distance toward the base. Beyond this the wing is transparent, the veins heavily infuscated, the tip often clouded. Hind thighs obliquely fasciate with fuscous externally. Face usually nearly immaculate; crown of head streaked, and disk of pronotum more or less fuscous, with a pale X-mark; dorsal and lateral fields of tegmina separated by a pale line broadening poste-

riorly and sometimes covering almost the entire dorsal field. Antennae short and slender, about equal to head and pronotum in female, a little longer in male.

This species was recorded by Smith from Norway, Me., and by Scudder from eastern Massachusetts many years ago. No additional records have been secured and nothing further is known regarding its occurrence in New England. If there was no error in labeling and the species was once found here, as is probable, a thorough survey should rediscover it, though it is possible that it may have become extinct in recent years in our territory. It is widely distributed through the southern and central States and is usually numerous where it occurs. The sandy coast-plain of southeastern Massachusetts and southwestern Maine very likely contains isolated colonies which have survived to the present day from a past age when a milder climate prevailed and the plain was continuous with that of New Jersey. During that period, numerous other species of plant and animal life entered New England by the same route and became widely distributed therein.

Judging from data secured in the southern States its life history differs decidedly from that of its relative, the Coral-wing, and agrees with that of the majority of the group. In Virginia and the South it matures in July and nymphs are numerous throughout that month. Search should be made for it in the month of August in old fields, wild land, and pastures on sandy soil.

Carolina Locust; Black-winged Locust; "Quaker."

Dissosteira carolina (Linné).

Figs. 1–12, 14, 16, 17.

Gryllus (*Locusta*) *carolinus* Linné, Syst. Nat., 10th ed., vol. 1, p. 433 (1758).
Locusta carolina Harris, Treatise, 3d ed., p. 176 (1862).
Oedipoda carolina Scudder, Boston Journ. Nat. Hist., vol. 7, p. 468 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 150 (1868); Rept. Ct. Bd. Agric. for 1872, p. 371 (1873).
Dissosteira carolina Fernald, Orth. N. E., p. 43 (1888).—Morse, Psyche, vol. 7, p. 87 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 96 (1911).

Head compressed; face nearly vertical; facial costa broad, sides but little constricted. Scutellum of vertex shallow, broad, the

mid-carina very low. Eyes about three times in side of head. Pronotum with front margin slightly angulate, hind margin about rectangular; median carina high, sinuate on prozone, arched on metazone, cut to the bottom by the principal sulcus; lateral lobes deeper than long, their sides nearly vertical, lower margin oblique, hind angle rounded. Tegmina about four and one-half times as long as wide, more than twice as long as hind femora, translucent on apical fourth. Wings broad, about one and one-half times as long as wide.

Brown, varying from yellowish sand-color to deep dull red and blackish slate; sometimes unicolor, sometimes maculate, sometimes trifasciate with fuscous. Wings brownish black, with pale buffy border, often maculate with fuscous at apex. Hind femora trifasciate with black on inside, and sometimes on outside. Hind tibiae yellowish or dusky, sometimes with paler annulus near base.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	34.5–42	24–28	28–33.5	12.6–14.7	9.5–11
Female	43.5–53	33–42	36–43	15.5–20.5	11.5–13 mm.

Owing to its widespread distribution from the Atlantic to the Pacific, its conspicuous size and coloration, its habits and haunts, this Locust is probably known to more people than any other of our common species. In this connection Blatchley's account leaves little to be said: "The black-winged locust . . . appears to be our most common species . . . because it frequents the highways and byways of man rather than the pastures and meadows where other grasshoppers are wont to congregate. Moreover, when disturbed, it more often betakes itself to the bare earth than to the green grass. Why this absurd taste? asks the person uninitiated in the doings of Nature's objects. For the simple reason that the dust of the roadside and the gravel ballast of the railway correspond so closely with the color of its back that its best friends and worst enemies will overlook it if it will only remain quiet. Yea, even that sharp-eyed connoisseur of grasshopper tidbits, the turkey-gobbler, oftentimes walks right over it, mistaking it for a wayside pebble."

Every roadside, footpath, and vacant lot with patches of bare soil is its home as well as the sandbank, the gravel-pit, and the

long stretches of sea-beach above the reach of the tides. It is an alert and wary species, keeping at a safe distance on warm summer days, and travels almost wholly by flight, using its relatively small hind legs chiefly as a means of launching itself into the air.

Its aërial evolutions at the mating season are notable and were well described by Townsend (Can. Ent., vol. 16, p. 167–168, 1884). Scudder quoted Townsend very fully (Ent. Soc. Ontario, 23d rept., p. 77, 1893) and added several observations of his own. Their remarks are given at length elsewhere in this work (p. 234).

This Locust appears early in July—about the first week—and is common until late in the fall. It is found throughout all but the more boreal parts of New England, southward to Florida, and from ocean to ocean.

Collared Locust; Barren-ground Locust.

Spharagemon collare (Scudder), and race **wyomingianum** (Thomas).

Plate 21, figs. 12, 13.

Oedipoda collaris Scudder, in Hayden's Geol. Surv. Nebraska, p. 250 (1872).
Oedipoda wyomingianum Thomas, Ann. Rept. U. S. Geol. Surv. Terr., vol. 5, p. 462 (1872).
Locusta aequalis? Harris, Treatise, 3d ed., p. 178 (1862).
Spharagemon collare Scudder, Proc. Boston Soc. Nat. Hist., vol. 17, p. 470 (1875).
Spharagemon aequale Scudder, *ibid.*, p. 468, in part.
Spharagemon aequale subsp. *scudderi* Morse, Proc. Boston Soc. Nat. Hist., vol. 26, p. 225 (1894).
Spharagemon oculatum Morse, *ibid.*, p. 232.
Spharagemon collare, race *scudderi* Morse, Psyche, vol. 7, p. 297 (1895).
Spharagemon collare race *wyomingianum* Morse, *ibid.*, p. 298.
Spharagemon collare vars. *scudderi* and *wyomingianum* Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 98 (1911).

Body moderately compressed. Head with crown and cheeks more tumid than in *S. bolli* and *S. saxatile*. Mid-carina of pronotum cristate, high on both prozone and metazone, the notch oblique, the two lobes often slightly overlapping. Posterior process distinctly acute-angled in both sexes.

Prevailing color brown, paler in *wyomingianum*, sand-color or light red but sometimes considerably infuscated; darker in *scudderi*, ranging from yellowish drab to deep rufous or claret brown

or dark fuscous. The markings are much less distinct than in either *S. saxatile* or *S. bolli* as a rule.

Disk of wings pale yellowish, the transverse black band broad, equal to one-fourth of wing or more, extending nearly to anal angle; beyond this transparent, the veins infuscated, and in the male the tip also. Hind tibiae and tarsi bright red, the spines black-tipped, the base often pale externally. Disk of pronotum sometimes marked with an indistinct pale X; very rarely, in New England specimens, the metazone is pale clay-color, producing the collared type of marking alluded to in the specific name, a pattern not uncommon in the West.

The two races intergrade and individuals are found which are intermediate in character. The smaller race, *wyomingianum,* is common extralimitally, but all of the New England specimens which I have seen are intergrades or typical *scudderi.* For a discussion of the characteristics of these and other races my two papers cited above (1894, 1895) should be consulted. The typical differences may be briefly stated as follows: *wyomingianum* is smaller; the head less compressed, especially above; eyes larger and more prominent; antennae longer proportionally; pronotum less compressed, and posterior process more acutely pointed; hind femora less distinctly fasciate externally, and internally the proximal fuscous band is obsolete ventrally and the proximal two are not connected,—in *scudderi* both are complete and broadly connected.

Measurements:—SCUDDERI.

	Total	Body	Tegmina	Hind femora	Antenna
Male	28.5–30.5	21–23	23 –24.5	13–14	11.5–12.5
Female	32 –35.5	27–29	25.5–28.5	14–16.5	11 –11.5 mm.

Measurements:—WYOMINGIANUM.

	Total	Body	Tegmina	Hind femora	Antenna
Male	23.5–26	18–20	18.5–20.5	11 –12	9.5–12
Female	29 –31.5	24–29	23 –25.5	12.5–15	10 –13 mm.

Scudder's Barren-ground Locust is a common species in southern New England from early July until October, in open sandy fields, generally numerous where found, and easily detected. It is, however, quite local, almost as much so as its congener the Ledge Locust, and probably for similar reasons in regard to the character of its habitat. Its flight is heavier, less powerful and erratic than that of either of its allies, and it is not difficult to cap-

ture though quite active on warm days. Its crepitation during flight is rather dull and less often sounded, though frequently heard when the insect is not alarmed.

It doubtless inhabits all of the New England States, having been taken, among other places, at Brunswick, Me.; Manchester, N. H.; in Vermont (Scudder); central and eastern Massachusetts—Easthampton, Essex Co., Wellesley, Cape Cod, Nantucket, Martha's Vineyard; and Thompson, Plainfield, Niantic, and North Haven, Ct.

Wyomingianum is said to be even more a sand-loving species than *scudderi*, frequenting sandy fields, either cultivated or untilled, and the margins of lakes, a habitat usually much paler in tint than the home of *scudderi*, as is indicated by its coloring. Typical examples occur on Staten Island., N. Y., and will probably be found in southern Connecticut.

Boll's Locust.

Spharagemon bolli Scudder.

Plate 21, fig. 16–19.

Spharagemon bolli Scudder, Proc. Boston Soc. Nat. Hist., vol. 17, p. 469 (1875).—Morse, Proc. Boston Soc. Nat. Hist., vol. 26, p. 227 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 99 (1911).

Spharagemon balteatum Scudder, Proc. Boston Soc. Nat. Hist., vol. 17, p. 469 (1875).

Dissosteira bollii Fernald, Orth. N. E., p. 43 (1888).

Body compressed. Mid-carina of pronotum equally compressed and elevated throughout; notch nearly vertical and usually closed, the anterior and posterior lobes of the carina never overlapping. Disk flat in longitudinal section; posterior process about rectangulate.

Color: yellowish to reddish brown in male, rusty brown to pale buff in female; the male averages much darker. Often a decided vinaceous tint is evident, and not infrequently individuals are seen of a claret brown or even Indian-red. Tegmina and hind femora usually more or less distinctly fasciate with dusky, more evidently so in male. Wings sulphur yellow bounded by a broad black band (narrower than in *S. collare*) which falls short of the anal angle and sends off a sub-frontal shoot toward base; beyond this band the wings are clear or smoky, and usually more (♂) or

less (♀) infuscated at tip. Hind tibiae fuscous at base, followed by pale and fuscous annulations, the distal half deep red, the tip fuscous, and the spines tipped with black.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male.....	26–30.5	20.5–22	20.5–25	12.5–13.5	10–13
Female.....	29–38	27.5–33	23 –28	12.5–17	11–13 mm.

Of all our species of Oedipodinae this is the only one which shows a marked preference for a semi-sylvan habitat, a preference which is even more noticeable in the South than in New England. While it is frequently found in fields, nevertheless it shows a decided predilection for open woods, bush-covered pastures, and abandoned fields growing up to sprout-land.

It has a strong, jerky, erratic flight, and circles, dodges, and drops down among the bushes on some bare spot in masterly fashion, asking no favors, thoroughly able to take care of itself, ever alert and ready for instant action. The females are less ready to rise and after one or two flights will often remain quietly in hiding.

Its rattling crepitation is a characteristic brush-land sound in August and September, and resembles that of the Autumn Yellow-wing but is of less volume and less prolonged in delivery. It is found throughout the Transition zone of New England from early July till late October, and is more generally distributed than either of its congeners.

Ledge Locust.

Spharagemon saxatile Morse.

Plate 10, fig. 1; Plate 21, figs. 14, 15; Plate 25.

Spharagemon saxatile Morse, Proc. Boston Soc. Nat. Hist., vol. 26, p. 229 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 100 (1911). This may be the *Locusta aequalis* of Harris, Treatise, 3d ed., p. 178 (1862).

Body stout, scarcely compressed in the male. Head of medium size; eyes medium, sub-prominent in male. Antennae long, of male exceeding hind femora, of female shorter, fuscous distally, annulate with pale at base. Pronotum stout, constricted on prozone, broad on metazone, hind margin rectangulate, front margin slightly obtuse-angled. Median carina rather low, on

prozone scarcely cristate, on metazone low but cristate anteriorly, fading out posteriorly; in profile sinuous on prozone, arcuate on metazone, the notch somewhat oblique, open. Lateral carinae distinct on metazone, indicated on prozone anteriorly; sulci rather deeply impressed. Tegmina broad, and passing the hind femora by one-fourth or one-third their length. Hind femora stout.

Color: brownish to blackish fuscous in spots and bands on an ash-gray ground. Tegmina and hind femora more or less fasciate. Hind tibiae fuscous at base, followed by a white ring, coral red distally, the spines black-tipped. The pronotum often shows an ash-gray X-mark. Disk of wings sulphur yellow, bounded by a broad black band reaching the anal angle and sending off near the anterior margin a broad short shoot half-way to base, the apical margin of the band nearly straight. Apical third of wing transparent, the apex either clear or infuscated.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	27–32.5	20–24	21.5–25.5	11.5–14	12–14.5
Female	32–39	28–34	25 –31	14 –17	12–14 mm.

The Ledge Locust finds life most to its taste in unsettled, somewhat wooded districts of a rocky, often elevated character. Here it may be seen during the latter half of the season crawling actively about on the lichened ledges, the tints of which its own colors exactly match, or flying from one to another, rattling loudly as it goes.

In life it is one of the handsomest of our New England Locusts and even cabinet specimens recall the cool gray of the rocks, the yellow glory of the goldenrod, and the reddened stems of trailing vines among its haunts. So well do its colors match those of its background—the pale greenish gray and ashy of the paler rock constituents and their lichen covering, the brown and black of the darker hornblende and mica and fragments of lichens, that it is nearly invisible when at rest.

Save for the hind tibiae, its coloring is exactly like that of the Snapping or Broad-winged Locust (*Circotettix verruculatus*) and its habitat is the same. The two species overlap slightly in distribution, but as a whole their ranges in New England supple-

ment each other. It is of interest to note that three species in the eastern United States belonging to three different genera have adopted the same habitat—a rather peculiar one, ledges and exposed rocky surfaces—and have taken on the same type of coloration. The third species is *Trimerotropis saxatilis* of the southern States.

While relying largely upon its protective coloring to escape notice, it is nevertheless an alert and active species, springing suddenly into the air when disturbed and flying for several rods if alarmed. Adults appear in the latter half of July and may be found until late in October. It is known from Gloucester, Salem, the Middlesex Fells, Waltham, Sherborn, the Blue Hills, Mass., and Thompson, Greenwich, and New Haven, Ct. Extralimitally it occurs in New Jersey and Maryland and a variety has been found as far south as Wytheville, Va. At Gloucester it lives on the same ledges with the Snapping Locust.

Marbled Locust.

Scirtetica marmorata (Harris).

Plate 10, figs. 9, 10; Plate 21, fig. 20–22.

Locusta marmorata Harris, Report, p. 145 (1841); Treatise, 3d ed., p. 179 (1862).

Oedipoda marmorata Smith, Rept. Ct. Bd. Agric. for 1872, p. 372 (1873).

Dissosteira marmorata Fernald, Orth. N. E., p. 44 (1888).

Scirtetica marmorata Morse, Psyche, vol. 7, p. 89 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 101 (1911).

Of medium size, a little compressed. Head medium. Eyes prominent. Antennae long, pale at base, infuscated at tip. Hind margin of pronotum obtuse or nearly rectangulate. Hind femora stout, cristate above and below.

Ground color varying from pale ash-gray to a claret or even Indian-red, sometimes largely infuscated. Head, thorax, and tegmina heavily marked with blackish. Pronotum often with a black stripe beneath the lateral carinae, fading out posteriorly, and another narrow, irregular one midway between it and the ventral margin. Middle of metazonal disk and anterior margin dusky, giving a pale X-mark effect. Tegmina typically heavily

infuscated posteriorly, with three large pale patches on the anterior margin:—1st, between basal fourth and half, separated from 2d by a heavy black patch; 2d, at about three-fifths, also succeeded by a black patch (both of these black patches are usually narrowed on the front margin of the tegmina). Beyond these lies a third smaller pale spot or maculate area which extends to the end of the tegmen. Disk of wings yellowish white to bright pale yellow, bounded by a broad black band extending from near anal angle to costal margin, at its broadest usually equal to one-fourth or two-fifths of the length of the wing; beyond this the apex more (♂) or less (♀) infuscated. Hind femora obliquely banded with black. Hind tibiae gray at base, red on distal half, clouded at apex and at basal third with fuscous.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	21.5–25	15–19	17 –20	9.3–10.7	10.5–12.5
Female	25 –29	22–25	20.5–22.5	10.5–12.5	9.5–10.5 mm.

The Marbled Locust is one of our handsomest and most attractive species, varying astonishingly in color, so much so, indeed, that any one accustomed to distinguish 'kinds' or species by this character would be led hopelessly astray.

Its preferred haunts are sandy areas, either bushy or open, and it is surprising how effective a protection its tints and markings make, notwithstanding their exceptional variety. This protective effect is brought about by 'camouflage,' the markings breaking up its outline and making it look like nothing in particular on the background of sand strewn with withered leaves and other fragments of vegetable débris. It is, however, conspicuous in flight, owing to its rattling crepitation and the contrasting tints of its wings. It is wary of approach, yet seldom flies far. Though usually numerous in its stations it is of very local and widely discontinuous distribution. Miss Susy C. Fogg has taken it at Manchester, N. H., and I have found it not uncommon at Provincetown, Dennis, and West Chop, Mass., and North Haven, Ct., associated with the Sand, the Seaside, and Boll's Locusts. Adults may be looked for from the latter part of July till November.

Sand Locust; Long-horned Locust.

Psinidia fenestralis (Serville).

Plate 10, fig. 3–5; Plate 21, fig. 23.

Oedipoda fenestralis Serville, Hist. Nat. des Ins., Orth., p. 726 (1839).
Oedipoda eucerata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 472 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 373 (1873).
Locusta eucerata Harris, Treatise, 3d ed., p. 180 (1862).
Psinidia fenistralis Fernald, Orth. N. E., p. 44 (1888).
Psinidia fenestralis Morse, Psyche, vol. 7, p. 112 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 103 (1911).

Body of medium size, of male slightly compressed, of female slightly depressed, the salient features of sculpture, such as the minor carinae and the sulci, accentuated. Eyes small but prominent. Disk of metazone minutely tuberculate, the hind margin a little acute with sides slightly concave, continuously arcuate with hind margin of lateral lobes. Tegmina very narrow, of nearly equal width throughout, apex rounded, sometimes tapering. Wings narrow, apex rounded, disk occupying scarcely more than two-fifths; the fuscous band at its broadest equal to disk, solid, reaching costal margin, fading out posteriorly; beyond this clear, veins infuscated, apex in male fuscous.

General color varying from pale ashy or buff through reddish brown to nearly black, according to the environment. A characteristic color pattern is evident in many individuals. This consists of a dark area covering the crown of the head and disk of pronotum, and often the dorsal part of the closed tegmina, bounded on the head by a narrow pale line extending back from each eye, which is continued on the pronotum mesad of the lateral carinae, giving a more or less hourglass-shaped dark area on the disk. Whatever the ground color or pattern of marking, the hind femora are almost invariably and conspicuously obliquely trifasciate with fuscous and the sutures of the ventral side of the thorax and abdomen decidedly darkened, giving a striking segmented appearance to the under side of the body. Hind tibiae pale, the apex and base dusky and usually a dusky cloud on the middle.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male.....	20–24	15–17.5	15.5–20	9–11.7	10.7–12.3
Female.....	23–30	19–25	17.5–24	11–13.5	10 –12 mm.

The disk of the wings is exceedingly variable in color. In northern New England it is prevailingly yellowish white, yellow, or even slightly orange. In southern Connecticut about half of the specimens captured have red wings, vermilion or sometimes pinkish. Farther west and south, beyond our borders, all are red-winged. The color doubtless deepens somewhat with age, as in various other insects, but this is quite insufficient to account for the variation found here. Probably climatic factors are responsible, but the subject needs investigation.

Wherever a stretch of wind-blown sand occurs, whether a vacant lot, a sand-pit, or along the sea-beach, the shores of inland lakes, and the banks and bars of rivers either of this or an earlier geologic age, there may be found the Sand or Long-horned Locust. It is a characteristic inhabitant of the extensive inland blown-sand area at Hoxie Station near Norridgewock, Me., and of the sea-beach at Nahant or Martha's Vineyard, Mass.; but it is equally at home on patches of loose dry sand of small extent which often are decreasing in size through the encroachment of plant life,—indeed, such are its usual habitats in the interior of New England.

It is a rather insignificant little creature, slender, almost wizzened in appearance owing to its constricted pronotum, accentuated sculpture, and narrow tegmina, and it closely resembles its background through a wide range of tints. It is usually plentiful where it occurs, though often very local in consequence of the nature of its habitat, which may be but a few feet in diameter. When disturbed it flies but a yard or two, erratically, often circling about, and owing to its small size and inconspicuous coloring is nearly invisible against the background, save when the wings are deeply tinted with red or orange. The male produces a slight, scarcely noticeable crepitation during flight, and stridulates with hind thighs against the tegmina when at rest on the ground.

It is frequently associated with the Seaside or the Marbled Locust in consequence of its habitat-preference, maturing earlier than either, however, in July or even the latter part of June, and flying for the remainder of the season. It is an inhabitant of all of the New England States, but probably not of their boreal portions; the following are some of the many localities recorded: Brunswick, Fryeburg, Norridgewock, Norway, and Standish, Me.;

Hampton Beach, Manchester, and North Conway, N. H.; Grand Isle and Hartland, Vt.; Nahant, Saugus, Revere, Plum Island, Provincetown, Sherborn, Wellesley, Nantucket, Penikese, and Cuttyhunk Islands, Mass.; Watch Hill and Block Island, R. I.; Thompson, Montville, Deep River, Canaan, and Stamford, Ct.

Seaside Locust; Maritime Locust.

Trimerotropis maritima (Harris).

Plate 10, figs. 7, 8; Plate 21, fig. 24.

Locusta maritima Harris, Report, p. 143 (1841); Treatise, 3d ed., p. 178 (1862).

Oedipoda maritima Scudder, Boston Journ. Nat. Hist., vol. 7, p. 472 (1862). —Smith, Rept. Ct. Bd. Agric. for 1872, p. 373 (1873).

Trimerotropis maritima Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 378 (1874).—Fernald, Orth. N. E., p. 129 (1888).—Morse, Psyche, vol. 7, p. 112 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 104 (1911).

Size medium to large. Body not compressed. Thorax of female somewhat depressed, broad; disk of pronotum flat, its hind margin about rectangulate, the mid-carina uniformly low but distinct, cut twice by the sulci; lateral lobes much deeper than long, usually angulate postero-ventrally. Antennae long, of male somewhat flattened, equal to hind femora; of female shorter. Tegmina long and relatively narrow, tapering toward apex, the apical fourth clear. Wings long and pointed. Hind femora stout.

Color: face, sides of thorax, outer side of hind femora, and anterior half of tegmina white, sprinkled with darker spots of yellow, brown, rufous, or fuscous; beneath white varied with luteous; above, buffy, brown, rufous or rarely even more or less fuscous. In general color this species varies in close accord with the soil of its habitat, from white to pale brown or gray, with darker blotches, which are sometimes nearly obsolete and again nearly confluent on the dorsal surface of head, pronotum, and tegmina. The grouping of the darker spots on the tegmina corresponds with the banding common in other species, covering the basal fourth in large part, numerous at or just beyond the half, very much scattered and fainter at the apical third or fourth and beyond. The spots are usually heaviest on the anterior

part of the discoidal area, leaving the triangular field behind it unspotted and often suffused with brown, rufous, or fuscous.

Disk of wings very pale whitish yellow, bounded by a narrow fuscous band about one-sixth as wide as the length of the wing, widest where it leaves the posterior margin, tapering anteriorly and posteriorly, discontinuous behind the submarginal offshoot, and fading out posteriorly midway between the widest point and anal angle. Beyond this the wing is clear, with some of the veins dusky, especially toward the apex. Hind tibiae white or yellowish white, the spines black-tipped. Hind femora with fuscous markings above at approximately two-fifths, three-fifths, and apex, the first more or less triangular externally.

Measurements.

	Total length	Body	Tegmina	Hind femora	Antenna
Male.....	28.5–33	20–25	23–27	11.5–14.5	11 –13
Female.....	36 –43	28–35	29–35	14.5–16.8	11.5–14 mm.

This species is easily recognized and is not likely to be mistaken for any other occurring in New England. Its variation in color according to the soil of its habitat is striking and is often marked even within a small area, as I once noticed at Block Island, where the Locusts frequenting a dark portion of the beach agreed with it in tint and differed from those from other parts of the island. At North Haven, Ct., specimens newly captured showed numerous bright rufous flecks, similar to the reddish tint of some particles of the soil.

Drifting gray or yellowish-white sands, dotted with pale-green waving tufts and masses of beach-grass (*Ammophila arenaria*), the roar of surf, the salt tang of spray-moistened winds, the blinding glare of summer sunshine reflected from sea and sand,—these are characteristic elements in the habitat of the Seaside or Maritime Locust on the beaches and adjoining dune areas of the Atlantic coast from Maine to North Carolina. I know of but one inland locality in New England, at North Haven, Ct., where it occurs sparingly on sandy wastes now several miles from the sea but at one time part of the sea-floor. A variety with heavier wing-markings, however, has been described from the shores of the Great Lakes.

Sand-color in tint, well-nigh invisible when at rest, and

extremely shy and wary, it whirrs away before the approaching intruder in rapid and prolonged flight, frequently going to a distance of many rods. Sometimes it flies with a subdued rattling crepitation, but its pale color and narrow wing-band make it comparatively inconspicuous against the background and correspondingly difficult to follow with the eye.

Adults have been taken in New England from the latter part of July to November, but it is most numerous, and a really common species in its haunts, in August and September. It is recorded from all the seaboard New England States from Pine Point, Me., southward.

Snapping Locust; Black Locust; Broad-winged Locust.

Circotettix verruculatus (Kirby).

Plate 21, fig. 25.

Locusta verruculata Kirby, Fauna Bor.-Amer., Insects, p. 250 (1837).
Locusta latipennis Harris, Rept. Ins. Inj. Veg., p. 144 (1841).
Oedipoda verruculata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 471 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 372 (1873).
Trimerotropis verruculata Scudder, in Hitchcock's Geol. N. H., vol. 1, p. 377 (1874).
Circotettix verruculata Fernald, Orth. N. E., p. 45 (1888).—Morse, Psyche, vol. 7, p. 113 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 105 (1911).

Body distinctly compressed. Head of moderate size; eyes rather prominent. Pronotum compressed anteriorly, metazonal disk flat, its hind margin rectangulate or slightly acute, the median carina low but distinct; lateral carinae distinct on metazone, indicated on prozone, obsolete on middle. Lateral lobes much deeper than long, the lower hind angles rounded. Tegmina rather broad and of nearly equal width. Legs weak, the hind femora noticeably small and slender.

General color, dark slate or black, either solid or mottled on a white or ash-gray ground, rarely with a brownish tone in life but frequently drying brownish. Sometimes the entire upper parts are practically black (whence one of the popular names), but usually the pattern gives a speckled effect exactly resembling weathered granite and is highly protective to the insect when

on its favorite background. The hind femora and tegmina are typically distinctly fasciate, the pronotum has an irregular gray X-mark bordering the lateral carinae internally, the face is mottled white and black, and the under parts dark gray. The hind tibiae are yellowish white with blackish base and apex and a dusky cloud at basal third. Disk of wings very pale yellow, bounded externally by a black band of very unequal width, much narrowed anteriorly and not continued to anal angle; beyond this clear and with the extreme apex clear or dusky. Occasionally individuals of a pale yellowish brown or ashy tint are seen, but as a rule this is the darkest colored of all our Locusts.

Measurements.

	Total	Body	Tegmina		Hind femora	Antenna
Male	26.5–32	21–23	20.5–25	(usu. 23–24)	11–11.5	9–11.5
Female	30.5–37	26–30	24 –28.5	(" 27–28)	13–14	11–11.5 mm.

Everyone who has rambled over the rocky pastures or climbed the mountains of northern New England in late summer or autumn has made the acquaintance of this sprightly creature, because of the loud crackling snaps with which it starts up before the traveler, and to which one of its popular names is due. While it is often seen upon roads and pathways or other areas of bare soil, whatever their color, it is characteristically a rock-inhabitant and its favorite haunts are exposed ledges on either high or low ground. On these it delights to bask in the sunshine, crawling about over the weather-beaten and lichen-covered surfaces whose tints its coloring matches, or to hover in the air above them, sharply stridulating.

Its 'song' in flight is the loudest produced by any of our Locusts and consists of a series of separate clicks or snaps (about five per second) rather than a rattle, and is readily distinguished by this peculiar snapping quality (for notation see Scudder's Distrib. Ins. N. H.).

It is one of the wariest of our Locusts, especially shy and difficult to approach during the warmer part of the day, when it often flies away to a distance of several rods and circles about, frequently returning to the place whence it was startled. Sometimes it beats up and down in the air, snapping loudly, or poises itself, hovering almost motionless, in a dance similar to that of

the Carolina Locust. The female occasionally makes a soft flutter or shuffling sound with the wings in flight, and both sexes can fly silently at will. The males often stridulate when on the ground, especially when in the presence of rivals or mates, pausing now and then during their rapid, jerky scrambles over the rocks to fiddle excitedly with their hind thighs on the wing-covers, producing a fine scritching sound audible to keen ears at a distance of several feet. Nor is this latter performance restricted to the male,—since the females are provided with similar apparatus and I have seen them use it, though unable, owing to distance, to detect any sound.

Adults begin to appear about the middle of July and are to be found during the remainder of the season. It is a boreal species, and occurs, even to the summits of the highest mountains, throughout Maine, New Hampshire and Vermont, most of northern and western Massachusetts, and in northern Connecticut. Some of the more southern localities where it has been found are Canaan and Colebrook, Ct.; Palmer, Cambridge (long ago), and Gloucester, Mass. It is very common on Mt. Agamenticus, Me., and throughout the vicinity. At Gloucester, Mass., it inhabits the same rocky outcrops as the Ledge Locust (*Spharagemon saxatile*), which strongly resembles it but which may be readily distinguished by having red hind tibiae and a single notch in the pronotum.

SPUR-THROATED OR SPINE-BREASTED LOCUSTS—LOCUSTINAE

(*Acridiinae of various authors*).

The members of this subfamily are characterized and readily distinguished by the presence of a prominent "Adam's apple," in the shape of a conical or cylindrical elevation projecting from the prosternum, termed the prosternal spine, a singular structure whose significance or use to the insect has yet to be explained. In point of numbers the group exceeds any other of the orthopteran subfamilies represented in New England; in size the species range from medium to very large, and include our largest Locusts.

The face is usually nearly vertical, though sometimes distinctly retreating; and the head is decidedly rounded in all its contours, while the pronotum likewise shows a lack of the angles

and roughnesses of the Acridine and Oedipodine series, caused largely by the prominent median and lateral carinae. The tarsal pulvilli are exceptionally large, a feature correlated with the characteristically plant-loving habits, these insects customarily perching on vegetation, in sharp contrast to the soil-frequenting habits of the Oedipodine or Band-winged Locusts.

The Locusts of this group are much less attractively colored than the Oedipodinae and Acridinae, though in the living state several of the species are decidedly handsome. The coloration is in general protective in character, but in some cases seems quite otherwise until the habits are known. It is mainly a combination of olivaceous, yellow, and rufous brown of varying shades, enlivened by ornamental touches of bright red or dull blue or greenish which are exposed on occasion. It is so variable individually, as well as in relation to environment and temperature, that it often has but little value for purposes of identification and reliance can be placed only on structural characters.

While the prevailing color of most of the species of Melanoplus (the dominant genus) is dull olivaceous, a striking variation occurs in *M. femur-rubrum*, *M. m. atlanis*, and *M. confusus*, in which individuals of both sexes and at least several stages are occasionally found which have the face and top of head and pronotum bright rose-red. They also vary much in color locally, according to the character of the station where found; and seasonally, whether collected early or late in the autumn. As a rule, specimens taken after a number of hard frosts are duller, darker, and more suffused than summer examples, the coloration of the individual being apparently considerably modified by such exposure.

Whether any of our species of this subfamily produce sound (other than a rustling of the wings in flight) has yet to be determined. Miss Fogg feels certain that she has both seen and heard the Rusty Locust (*Schistocerca alutacea rubiginosa*) stridulate. Scudder reports seeing the Red-legged Locust (*Melanoplus femur-rubrum*) make apparently stridulatory movements. I have seen, during the past summer (1919), the Two-striped Locust (*Melanoplus bivittatus*) make pronounced and oft-repeated motions of the hind legs similar to those made by Slant-faced and Band-winged Locusts when stridulating, with this difference: the hind femora were not applied or

even approximated to the tegmina but held apart therefrom, diverging from each other at an angle of from 75° to 85°. The performance was repeated for several minutes on different occasions, as long as I cared to watch, and by both sexes, the female taking the initiative and maintaining the movements longer than the male. No sound was heard unless the feet came in contact with vegetation or the box in which the insects were confined. What may be the significance of this movement and its relation to the stridulatory movements of other Locusts remains a subject for investigation. Neither hind femora nor tegmina bear rasps, and flight is accompanied by a buzz or rustle only, not by a rattle or crackle. Nevertheless, the auditory tympana at the base of the abdomen are large and probably function as organs of hearing. Owing to the lack of stridulatory habits they appeal less to human interest. However, at least two species are ranked as seriously injurious to crops and have several times caused severe and widespread damage; another is peculiar in being almost purely arboreal in habits, both in feeding and in oviposition; two are among the largest species found in the country; and several are notable for the great reduction in size of the tegmina and wings. Aside from these items, the chief point of interest about them lies in their relation to habitat,—their distribution, local and general,—one species, indeed, though equipped with neither tegmina nor wings inhabits a very wide extent of country from the boreal regions of Maine and Canada, southward along the cooler Appalachian summits as far as North Carolina.

Eighteen species of this group have been taken in New England, all but two of which are native. These are divided among five genera. Since the genera are, for the most part, very closely related, the key to species is made up independently of generic characterization. Our species are easily recognized with the exception of the females of Melanoplus, which are unquestionably the most difficult to discriminate of all our Locusts, owing to the variability of every available character.

Key to Species of Locustinae (Acridiinae).

(See Plates 22, 23.)

A. Without trace of tegmina or wings; dark olive green above, with or without a pale dorsal stripe. Length one inch or a little less.

B. Cerci of male relatively stout, the middle distinctly more than half as broad as the base. White Mountain Wingless Locust, *Podisma glacialis glacialis*, p. 492.

[BB. Cerci of male slender, the middle less than half as broad as the base. Varied Wingless Locust, *P. glacialis variegata*, p. 495.]

AA. Tegmina present.

C. Size large, tegmina one inch or more in length. Subgenital plate of male deeply notched.....Schistocerca spp.

D. Very large, tegmina 42 (♂) to 55 (♀) mm. long. Body and tegmina brown, conspicuously varied with ashy and yellow stripes and dusky spots; mid-dorsal line of head, pronotum, and tegmina, and costal margin of latter pale. American Locust, *Schistocerca serialis*, p. 488.

DD. Smaller, tegmina 26 to 40 mm. long. General coloration ranging from rusty brown through yellowish brown to olive green, often with a pale dorsal stripe.

E. Vertex more prominent; pronotum more compressed and tectiform; bright yellow mid-dorsal stripe. Leather-colored Locust, *S. alutacea alutacea*, p. 490.

EE. Vertex less prominent; pronotum less compressed; usually without conspicuous pale mid-dorsal stripe. Rusty Locust, *S. alutacea rubiginosa*, p. 490.

CC. Size medium or small, tegmina not over an inch in length.

F. General coloration pale bluish green with a conspicuous purplish stripe on mid-dorsal line of pronotum, tegmina, and abdomen. Pronotum deeper than broad. Small, 16 to 24 mm. Antennae short, about equal to head and pronotum, pink. Hind tibiae greenish blue. Cerci of male straight, tapering evenly to a sharp, conical point.....Purple-striped Locust, *Hesperotettix brevipennis*, p. 495.

FF. Not as above, coloration usually dull brownish or olivaceous, the tegmina always so.

G. Hind tibiae bright greenish blue. Rather large, hind femora slender, of male about 12 mm., of female about 16 mm. long, not transversely banded. Tegmina at least twice as long as pronotum, unmarked. Antennae very long, of male twice, of female one and a half times as long as head and pronotum. Cerci of male caliper-like, slender, usually symmetrical, the tips a little expanded, incurved. Swamp Locust, *Paroxya clavuliger*, p. 497.

GG. Not as above.....Melanoplus spp. [and Phoetaliotes.]

Key to Species of Melanoplus,

Males.

a. Tegmina no longer, or but little longer, than the pronotum.

b. Furcula large, nearly twice as long as last dorsal segment, its fingers broad, flat, tapering. Cerci short, flat, scarcely twice as long as their basal width, rapidly narrowed dorsally on basal half to one-half or one-third their basal width, thence equal, curved upward, with blunt, almost truncate apex.

Dawson's Locust, *M. dawsoni*, p. 516.

bb. Furcula very short, often scarcely noticeable.

c. Cerci relatively broad throughout, usually somewhat triangular.

d. Hind tibiae greenish. Subgenital plate very short (its ventral margin less than its depth), ending in a very acute, upturned tubercle. Cerci very nearly symmetrical. Color black or greenish gray, lateral stripe of pronotum broad, percurrent; hind femora fasciate.....Green-legged Locust, *M. viridipes*, p. 522.

dd. Hind tibiae red. Subgenital plate conical, bluntly pointed, little upturned. Cerci with ventral margin strongly convex, dorsal margin concave, a little twisted near apex, which is shallowly sulcate externally.....Scudder's Locust, *M. scudderi*, p. 520.

cc. Distal half of cerci narrow, less than half as wide as base.

e. Hind tibiae red. Tegmina shorter than pronotum. Cerci narrowed rapidly on dorsal side of basal half to one-third or one-fourth their basal width, the distal half of nearly equal width throughout, curving slightly upward and inward, flattened externally, apex bluntly rounded....Smith's Locust, *M. mancus*, p. 518.

ee. Hind tibiae greenish blue. Tegmina longer than pronotum, lanceolate, acutely taper-pointed or acuminate. Cerci straight, erect, tapering equally on basal half or two-thirds, the tip very narrow, pointed. Head exceptionally large. Probably adventive.

Large-headed Locust, *Phoetaliotes nebrascensis*, p. 524.

aa. Tegmina much longer than pronotum.

f. Subgenital plate distinctly notched apically. Tegmina reaching or passing hind knees. Cerci short, scarcely twice as long as wide; and subtrapezoidal, the distal margin oblique, the apex dorsal and broadly rounded.....Lesser Migratory Locust, *M. mexicanus atlanis*, p. 499.

ff. Subgenital plate not notched at apex.

g. Cerci simple in outline, nearly straight.

h. Furcula very short. Cerci long, three to four times as long as wide and subequal in width throughout; apex rounded, a little ventral.

Huckleberry Locust, *M. fasciatus*, p. 501.

hh. Furcula long, much longer than last dorsal segment.

i. Cerci tapering, the distal half less than half as wide as extreme base.....Red-legged Locust, *M. femur-rubrum*, p. 503.

ii. Cerci of nearly equal breadth throughout, subtrapezoidal, dorsal margin concave, apical margin oblique, apex dorsal, rounded. Northern Locust, *M. borealis*, p. 506.

gg. Cerci of irregular shape.

j. Cerci expanded apically.

k. Cerci roughly sock-shaped, the expansion chiefly dorsal to the axis. Hind femora robust, not fasciate. Two-striped Locust, *M. bivittatus*, p. 514.

kk. Cerci expanded on both sides of the axis, often nearly symmetrical, the greatest width across expansion nearly equal to the total length. Hind femora slender, fasciate. Pine-tree Locust, *M. punctulatus*, p. 511.

jj. Cerci forked, the dorsal branch much the broader. Broad-necked Locust, *M. luridus* p. 509.

jjj. Cerci with apical half two-thirds as wide as quadrate basal half, diverging from it at an angle of 45° upward and inward, rounded and shallowly sulcate externally. Little Locust, *M. confusus*, p. 507.

FEMALES.[1]

l. Tegmina no longer or but little longer than pronotum.

m. Hind tibiae red.

n. Tegmina broadly oval, shorter than pronotum. Lateral lobes of pronotum much longer than deep, the upper half strongly contrasted in color with the lower. Body not compressed. Hind margin of pronotum rounded, nearly truncate. Mid-carina of pronotum distinct on metazone only. Metepisternum with pale streak. Hind femora usually not fasciate..... Smith's Locust, *M. mancus*, p. 518.

nn. Tegmina lanceolate, acuminate, very acutely taper-pointed, longer than pronotum. Lateral lobes of pronotum about as deep as long, lateral stripe well developed on prozone, lacking on metazone. Body not compressed. Hind margin of pronotum a little extended,

[1] In using this table it should be distinctly understood that complete reliance cannot be placed on any single character, so great is the similarity between species and so wide the range of individual variation. In many cases all available characters need to be considered in order to determine with certainty the species to which a given specimen belongs. For these reasons, in order to facilitate identification, I have here summed up the more important characteristics of each species, instead of simply stating one or two as in ordinary cases. In addition to the points stated in the table, the measurements, date, and locality may be found helpful. From 90 to 95% of the specimens examined will be readily determined by this table, most of the remainder with a little trouble, and about 2 or 3% not until the student has become thoroughly familiar with all of the species here considered. *M. bivittatus* will be recognized at once by its size; *M. punctulatus* by the form of the ovipositor; and *M. confusus*, less readily, by the same means.

the angle rounded. Mid-carina of pronotum on metazone only. Metepisternum with pale streak. Hind femora fasciate.

Dawson's Locust, *M. dawsoni*, p. 516.

nnn. Tegmina lanceolate, equaling or exceeding pronotum, bluntly pointed. Lateral lobes as deep as long; lateral stripe wanting or but faintly indicated. Body compressed. Mid-carina of pronotum distinct throughout. Hind margin of pronotum decidedly extended, angulate. Metepisternum without pale streak. Hind femora not fasciate.

Scudder's Short-winged Locust, *M. scudderi*, p. 520.

mm. Hind tibiae green, gray, or bluish.

o. Tegmina with bluntly rounded apex, equally as long as pronotum. Lateral lobes of pronotum much longer than deep; lateral stripe continuous or nearly so. Body not compressed. Head smaller, vertex projecting but little. Ovipositor with scoop of upper valves relatively long, not angulated at base, and all valves very acutely pointed.....Green-legged Locust, *M. viridipes*, p. 522.

oo. Tegmina very acutely taper-pointed, distinctly longer than pronotum. Lateral lobes nearly as deep as long; lateral stripe lacking on metazone. Body compressed. Head large, face strongly retreating; vertex very prominent, projecting more than half the diameter of the eye. Ovipositor with scoop relatively short and angulated at base, and valves bluntly tipped. Head exceptionally large.

Large-headed Locust, *Phoetaliotes nebrascensis*, p. 524.

ll. Tegmina much longer than pronotum.

p. Large, robust; hind thighs 16 mm. or more long (usually 18 to 19). Dorsal area of closed tegmina separated from lateral area by a pale streak which sometimes suffuses entire dorsal area.

Two-striped Locust, *M. bivittatus*, p. 514.

pp. Smaller; hind thighs not over 14 mm. long.

q. Lower valves of ovipositor about straight, the lateral tooth nearly or quite obsolete. Interspace between mesosternal lobes transverse. Tegmina maculate with dusky. Hind femora slender, fasciate externally, cherry red within at base.

Pine-tree Locust, *M. punctulatus*, p. 511.

qq. Lower valves of ovipositor with the apex more or less distinctly decurved and with a distinct lateral tooth midway of the lower outer margin.

r. Tegmina usually passing end of hind thighs, body relatively slender, pronotum in side view often depressed at principal sulcus, with smaller, uninflated prozone. Interspace between mesosternal lobes longitudinal or quadrate.

s. Tegmina more or less flecked with dusky and pale spots along the middle. Hind thighs usually showing more or less distinct fuscous bands, at least on dorsal side. Upper valves of ovipositor angulated at base of scoop.

t. Prosternal spine nearly cylindrical, the tip bluntly rounded, often bulbous. Cerci once and a half or twice as long as wide, sharply pointed, somewhat acuminate, the sides slightly concave. Ovipositor seen from the side with basal part of scoop longer, the angle between scoop and stem more obtuse. Hind tibiae red. Hind thighs largely or wholly lacking transverse dusky bands except on dorsal part of inner face. Mid-carina of pronotum frequently distinct on prozone.....Red-legged Locust, *M. femur-rubrum*, p. 503.

tt. Prosternal spine tapering, the tip pointed. Cerci shorter, only about one and one-third times as long as wide, rather dull at tip, the sides straight or convex. Upper valves of ovipositor with scoop shorter, the angle at junction with stem more pronounced. Hind tibiae either glaucous or red. Hind thighs usually with conspicuous dusky oblique bands. Mid-carina of pronotum seldom distinct on prozone.

Lesser Migratory Locust, *M. mexicanus atlanis*, p. 499.

ss. Tegmina and hind thighs immaculate or showing only faint traces of spots or bands. No angulation at junction of scoop and stem of ovipositor. Prozone fuller proportionally, the dorsal line of pronotum horizontal. Interspace usually subquadrate or transverse.

Northern Locust, *M. borealis*, p. 506.

rr. Tegmina usually not passing end of hind thighs; body relatively stout, and prozone full (giving a thick-necked appearance). Interspace between mesosternal lobes usually subquadrate or transverse (rarely quadrate).

u. Tegmina reaching to about the end of the hind thighs. Interspace but little transverse.

v. Scoop of ovipositor very short, deeply concave, with a single or no denticulation at base of outer edge; lower valves with the tips correspondingly short and decurved. Hind tibiae usually glaucous but often red. Tegmina flecked with dusky and pale spots, hind thighs obliquely banded. Lateral carinae of pronotum usually bordered below on the prozone by a broad fuscous stripe which is crossed obliquely by a distinct, narrow pale line. Prozone less inflated than in next species and body less robust.

Little Locust, *M. confusus*, p. 507.

vv. Scoop rather long, the outer edge of basal half crenulato-denticulate, the tips of both pairs of valves long and evenly tapering. Hind tibiae coral red. Fuscous stripes on prozone indistinct, often lacking. Tegmina maculate and hind thighs obliquely banded. A robust species with noticeably swollen prozone and a thick-necked aspect.

Broad-necked Locust, *M. luridus*, p. 509.

uu. Tegmina usually reaching but half or two-thirds the length of the hind thighs (rarely five-sixths). Interspace rather strongly transverse.

w. Hind thighs with conspicuous dusky bands, at least above. Hind tibiae red. Tegmina usually dark brown, flecked with dusky and pale spots. A robust species with strongly transverse interspace. Prosternal spine variable, rather short. Ovipositor similar to that of *M. borealis* or a little stouter. (Very rarely examples are found with tegmina and wings considerably exceeding end of hind thighs.)

Huckleberry Locust, *M. fasciatus*, p. 501.

ww. Hind thighs not obliquely banded, rarely with traces of dusky on dorsal part of inner face. Hind tibiae variable. Tegmina brownish olive, immaculate or very nearly so. General color varying from greenish to brownish olive above with black markings; luteous below, sometimes cherry red on underside of hind thighs and tibiae. Interspace varying from subquadrate to rather strongly transverse. Tegmina very variable in length, sometimes passing hind femora. Prosternal spine variable, most resembling that of *M. femur-rubrum*. Scoop of ovipositor in side view without angulation at junction with stem.....Northern Locust, *M. borealis*, p. 506.

American Locust.

Schistocerca serialis (Thunberg).

Fig. 85; Plate 22, figs. 1, 2.

Gryllus serialis Thunberg, Mém. Acad. Imp. Sci. St. Pétersbourg, vol. 5, p. 241 (1815).

Libellula americana Drury, Illus. Nat. Hist., vol. 1, p. 128, pl. 49, fig. 2 (1770).

Schistocerca americana Morse, Psyche, vol. 8, p. 271 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 108 (1911).

Very large, but of graceful form. Face slightly retreating. Antennae about equal to head and pronotum. Prosternal spine long, cylindrical, tapering a little to a dull point, slightly curved backward. Mid-carina indicated on metazone. Tegmina very long, narrow. Wings ample. Last abdominal segment (♂) not enlarged; subgenital plate elongate, tapering, deeply and acutely V-notched at tip. Supra-anal plate elongate, narrow, somewhat trisulcate, the sides sinuate, strongly narrowed before the almost cuspidate tip. Furcula not developed. Cerci of male one and

one-half times as long as broad, tapering a little to a broad, truncate tip which is shallowly sulcate externally. Cerci of female short, broadly lanceolate.

Color: reddish or yellowish brown above, much varied with spots and stripes, yellowish beneath. A broad yellow middorsal stripe from vertex to end of dorsal field of tegmina. Eyes brown. Face yellow, with dusky stripe running downward from eyes. Sides of prozone with three longitudinal yellow stripes on dorsal and ventral margins and in middle; sides of metazone yellow. Sides of meta- and mesothorax with wide yellow oblique stripes. Tegmina semitransparent on distal portion, heavily maculate with dark brown spots, and yellow along costal border.

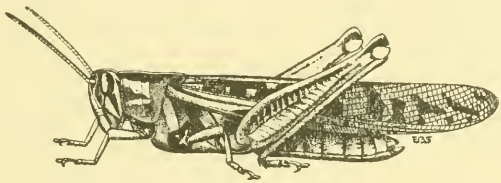

Fig. 85.—American Locust, *Schistocerca serialis.* Male. (After Lugger.)

Wings transparent, veins yellow toward base. Hind femora yellow with one or two dusky streaks on outer face. Hind tibiae yellowish or red, spines yellow, tipped with black.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	52–55	39–42	42–44	23–24	12
Female	62–68	48–55	50–55	28–30	13–15 mm.

This large and handsome Locust will be recognized at once by its great size and conspicuous markings. It occurs in New England but rarely, and must be considered as a purely adventive species, a wanderer from the Southwest. It has been repeatedly observed near New York City and it probably reaches southwestern Connecticut not infrequently. Walden reports taking a female at Hamden, Ct., a few miles north of New Haven on August 23. Mr. F. H. Sprague reported finding it at Wollaston, Mass., near Boston, on October 1, 1883, "tolerably abundant in one spot on the beach, among the tall grass below high-tide mark." No satisfactory explanation of its occurrence in numbers at this

locality has ever appeared, and no specimens have been seen since. It is, however, a species of wide distribution and powerful flight and its presence in Connecticut may be expected at any time. It ranges over the eastern part of the United States, the West Indies, and a large part of South America.

Its flight is extended, swift, somewhat jerky, and rustling, and it perches indifferently on all sorts of vegetation from tall grasses and weeds to trees, rarely alighting on the ground. Rank growths of grass, weedy jungles, shrubby pastures, and stubble-fields are its usual haunts, though it may be met with almost anywhere.

In the southern States adults occur throughout the year, but are said to be more plentiful in autumn. Its life history varies much with the latitude, and irregularities are probably largely due also to variations in time and place of oviposition and rate of development.

Rusty Locust; Leather-colored Locust; Striped Rusty Locust.

Schistocerca alutacea (Harris) and **Schistocerca alutacea rubiginosa** (Scudder).

Fig. 86; Plate 12, fig. 2; Plate 22, figs. 1, 2.

Acrydium alutaceum Harris, Rept. Ins. Inj. Veg., p. 139 (1841); Treatise, 3d ed., p. 173 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 373 (1873).

Acridium alutaceum Fernald, Orth. N. E., p. 31 (1888).

Schistocerca alutacea Morse, Psyche, vol. 8, p. 270 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 108 (1911).

Acridium rubiginosum Scudder, Boston Journ. Nat. Hist., vol. 7, p. 467 (1862).—Fernald, Orth. N. E., p. 31 (1888).

Schistocerca rubiginosa Morse, Psyche, vol. 8, p. 269 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 109 (1911).

Large, with robust thorax, particularly in the female. Face nearly vertical. Antennae ranging from equal to nearly twice as long as head and prothorax. Pronotum rounded above, sometimes a little tectiform, the disk of metazone somewhat flattened; mid-carina distinct or obsolete, lateral carinae absent. Tegmina long; wings long, transparent, or a little yellowish toward base. Feet and legs large, with coarse spines and very large pulvilli. Cerci of male oblong, one and one-half times as long as wide, apex shallowly sulcate, sides a little convex, apical margin a little oblique, emarginate or concave. Cerci of female

broadly ovate-lanceolate, bluntly pointed. Apex of subgenital plate deeply V- or U-shaped emarginate. Furcula indicated by two slight widenings of posterior margin of last dorsal segment.

Color: unstriped phase.—Rusty brown above, either nearly uniform or with the tegmina thickly marked with slightly darker spots; beneath brownish yellow. The ground color above varies from reddish to yellowish in tint and sometimes in late autumn to an olive gray with rusty tegmina. Rarely, a yellowish mid-dorsal stripe is present. The spines of the hind tibiae are yellow with black tips and often contrast strongly with the tibiae. *Striped phase:* generally rusty yellow above, paler beneath, the tegmina of the female often with darker spots. A conspicuous pale yellow mid-dorsal stripe extends from vertex of head to end of tegmina. Frequently the color of fresh specimens, females particularly, is a deep olive green on the sides of the body and face of the hind femora, largely supplanting the rusty tint over the entire body.

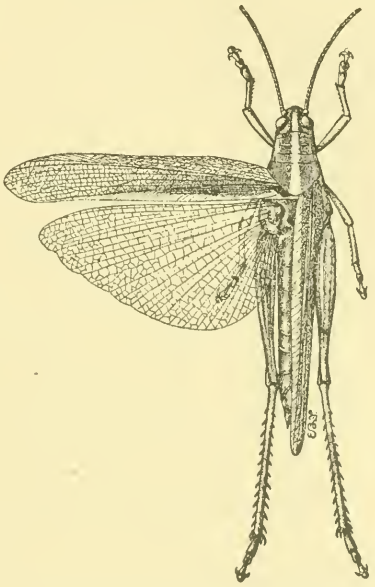

Fig. 86.—Striped Rusty Locust, *Schistocerca alutacea alutacea*. Female. Wings of left side spread. (After Lugger.)

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	33–39	28–33	24–30	16 –19.5	13–17
Female	44–54	39–54	32–42	20.5–27	14–17.5 mm.

The two forms—which may be distinguished as the striped and the unstriped—of this species as found in New England, usually present certain differences in structure, color, and habitat that lead some entomologists to regard them as specifically distinct, but the consensus of opinion at the present time is that

they should not be so regarded. Typically, the unstriped form has a less compressed head and prothorax, wider and less prominent vertex and facial costa, often slightly stouter fore femora and shorter hind femora. This form inhabits dry areas on sandy and gravelly soils, railroad embankments, etc., clothed with bunch-grass, scrub-oak, sweet-fern and pitch-pine thickets. The striped form is characteristic of wet, swampy tracts, among rank grass, weeds, and bushes. What the relation is between the two forms and their different environments has yet to be determined.

S. rubiginosa has been taken at Manchester, N. H. (Fogg); Andover, Peabody, Dedham, Wellesley, and Provincetown, Mass.; and in numerous localities in Rhode Island and Connecticut. *S. alutacea* is known from Wareham and West Chop, Mass., and several localities in southern Connecticut. Dates of capture of adults range from August 5 to October 30. Owing to the greater activity of the males, this sex seems greatly to outnumber the other, though both fly freely and far, frequently alighting on tall bushes and trees after being flushed from the grass of the swamps where they live.

This species is distinctly injurious when occurring in numbers on or near cranberry bogs, owing to its destruction of the growing cranberries, which it bites open and destroys in search of the seeds.

White Mountain Wingless Locust.

Podisma glacialis (Scudder).

Plate 11, fig. 6–8; Plate 23, figs. 17, 18.

Pezotettix glacialis Scudder, Boston Journ. Nat. Hist., vol. 7, pp. 630, 631, pl. 14, figs. 9, 10 (1863).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 149 (1868).—Fernald, Orth. N. E., p. 29 (1888).

Podisma glacialis Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 98 (1897).—Morse, Psyche, vol. 8, p. 272 (1898).—Walker, Can. Ent., vol. 35, p. 295 (1903).

Body subcylindrical, of female somewhat depressed, and abdomen weakly carinate above. Interspace between mesosternal lobes strongly transverse. Antennae shorter than hind femora in male, three-fourths as long in female. Tegmina and wings absent. Fore and middle femora of male enlarged; hind femora

of both sexes rather slender. Abdomen of male recurved at apex, the subgenital plate tuberculate posteriorly. Cerci long, straight, tapering in basal half to two-thirds or one-half their basal width, flattened at the tip, which is rounded dorsally, angulate ventrally, black. Furcula processes slender, tapering, black, about twice as long as last dorsal segment.

Color: dark olive green above; yellowish or greenish white beneath, legs greenish, hind femora rich cherry red beneath. Lateral lobes of pronotum white below, greenish black on dorsal half, this continued anteriorly and posteriorly on head and thorax and in male along sides of dorsum of abdomen. In the male a dorsal median stripe of greenish yellow or white covers pronotum, and is continued backward as a row of spots on abdomen. Eyes olive brown. Hind tibiae green, hind femora often indistinctly fasciate. Entire body thinly clothed with moderately long, colorless pubescence. Surface of body of male shining, of female waxy. In young examples of both sexes, and rarely in adults, the color above is not solid but mottled, giving a variegated appearance. Rarely (in the female especially), the olive green of the upper surface is suffused with claret red.

Measurements.

	Body	Hind femora	Antenna
Male	15–17.5	9.5–10.8	8–9
Female	19–28	10 –12	7–8.5 mm.

This singular species received the name of Wingless Mountain Locust from specimens captured in the White Mountain region of New Hampshire, but, as we know today, it is a mountain species only in the warmer part of its range. It is a common and widely distributed inhabitant of the colder and damper parts of the boreal area of New England, being more completely at home in the moist zone of the mountains and the damp forests and brushy bogs and swamps of the northern and eastern sections. It is a thicket-lover and as such is characteristic of the subalpine region of the higher mountains, but search has revealed that it is equally common at low levels in similar conditions. Thus, in Maine, I have found it in sphagnum bogs near Lake Umbagog but slightly above the lake level (about 1,250 feet); Harvey (Psyche, vol. 8, p. 77, 1897) took it at Jackman at an elevation of approximately 500 feet in open woods and bogs;

and in the summer of 1913, I secured it at Orono on the shrubby margin of a sphagnum bog at 140 feet, and at Roque Bluff, also on a bog, practically at sea level, and within a few rods of the sea-shore.

Exact data are of exceptional interest in this connection and may be given at this point. Specimens have been studied from the following localities and unless otherwise accredited were taken by the writer:—Machias, Roque Bluff, Whitneyville, Cherryfield, Houlton, Mt. Katahdin (F. P. Briggs), Orono, Jackman (Harvey), and Speckled Mt. (2600–2800 ft.), Oxford Co., Me.; Mt. Pequawket and Mt. Washington (3100 to 5500 ft.), N. H.; Mt. Mansfield, Killington Peak, Ascutney Mt., and Mt. Equinox, Vt.; and Mt. Greylock, Mass. These more southern mountain tops maintain a suitable boreal environment now cut off, like so many islands, from the main body of similar conditions, and the presence of this Locust upon them is a parallel case to that of the White Mountain butterfly (*Oeneis semidea*) whose nearest kin are to be found in Labrador.

This is a sluggish insect and often escapes notice among the vegetation of its haunts by reason of its inconspicuous green color. The males, however, are good leapers on occasion and on bright warm days become fairly active, yet both sexes may often be taken in the hand. If alarmed, one or two quick leaps place them in security in the recesses of the covert, whence they slowly emerge, with an air of deliberative curiosity. In the cool, moisture-laden atmosphere of their haunts they live, literally and figuratively, a quiet life. They cannot fly from place to place, they cannot even flutter or call to their mates. When clouds pass over the sun they hide away, and when it reappears they likewise emerge and crawl sluggishly about, basking in the grateful warmth. Where they are numerous, a 'watchful waiting' policy is wisest for the student in favorable weather conditions, but the sweep-net is the most effective means of discovery.

This Locust does not seem to be associated in habits with any particular plant or family of plants. Scudder recorded it on the "close branches of the dwarf birch (*Betula nana*)" in the White Mountains; I have usually found it on or among some of the various species of Ericaceae characteristic of the bogs and mountain tops, but it is also fond of raspberry and blackberry bushes;

my largest series, in several different stages, was obtained in a raspberry thicket which had sprung up in a little clearing in the forest. Walker says that in Ontario it frequents the beaked hazel and arbor-vitae, and the southern variety has been reported from hemlock in Pennsylvania.

The species is represented in New England, so far as known, only by the typical form with broad cerci. Both this and the southern variety with narrow cerci, *P. g. variegata*, are recorded from Ontario by Walker. The latter form was described from Ithaca, N. Y. I have found it common in the Catskill Mountains (Kaaterskill High Peak, 3800 ft.) and the southern Appalachians (Grandfather Mt., Roan Mt., Balsam Mts., 3800 to 5500 ft.). It has been reported also from Pennsylvania (Rehn *et al.*) and as far west as Minnesota (Somes). This extended distribution of an entirely flightless boreal Locust, whose only practical means of dispersal is by its own unaided leaps, is of special interest in revealing the long period of time and the very gradual change of conditions during the withdrawal of the great ice-sheet from northeastern America. Not by extended flights of many miles at a time was the land in the wake of the retreating ice-sheet repeopled by this species, but by hopping, hopping, hopping, a foot or a yard at a time, pressing northward as the vegetation and circumstances permitted, clambering up the mountains as fast as the forest line advanced, dying out in the southern areas and on dry slopes as "the fatal sea of warmth filled the valleys below" and swept onward far to the north, until now such colonies as that on the summit of Ascutney Mt. are forever cut off from their kind.

Purple-striped Locust; Purple-striped Green Locust.

Hesperotettix brevipennis (Thomas).

Fig. 87; Plate 11, figs. 1, 2; Plate 23, figs. 19, 20.

Ommatolampis brevipennis Thomas, Bull. U. S. Geol. Surv. Terr., ser. 1, vol. 1, no. 2, p. 67 (1874).

Hesperotettix brevipennis Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 63, pl. 5, fig. 2 (1897).—Morse, Psyche, vol. 8, p. 271 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 110 (1911).

Of small size and pleasing coloration, the female appearing rather stout owing to the brevity of the tegmina and wings.

Face decidedly retreating, the vertex prominent, and the eyes closely approaching each other on the top of the head. Pronotum with distinct, percurrent median carina, lateral carinae wanting. Prosternal spine conical in female, slender and tapering in male, sharply pointed. Tegmina narrow and short, extending about one-half the length of the hind femora, leaving end of abdomen uncovered. Hind femora of medium size. Subgenital plate ending in a submarginal tubercle; the base of the dorsal margin much ampliate. Supra-anal plate triangular, pointed, the sides straight. Cerci symmetrical, triangular, twice as long as width of base, tapering evenly to a conical point. Furcula reduced to a pair of small flattened tubercles.

Fig. 87.—Purple-striped Locust, *Hesperotettix brevipennis pratensis*. Female. (After Lugger.) The New England form has shorter tegmina and wings.

Color: bluish grass-green, darker above, yellowish beneath, striped with purplish red on dorsal mid-line of pronotum and abdomen, dorsal field of tegmina, and femora. Antennae reddish. Eyes brown. Vertex of head with dusky spot, sometimes continued backward over occiput. Dusky lateral stripe of pronotum restricted to prozone, narrow, irregular. Hind tibiae green or blue; spines pale at base, black-tipped. External and internal genicular spots of hind femora black. Whitish lines, often bordered with dusky purple, run downward from the eyes, below lateral stripe on prozone, and obliquely on sides of meso- and metathorax.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	15–17	7.6–10	9.5–10.5	7.25–8.5
Female	20–24	9.7–11.7	11.8–12.7	6.3 –7.2 mm.

This daintily colored Locust was described by Thomas from specimens from Georgia. Later it was found in New Jersey by Uhler. In 1903 and 1905, I captured it in northwestern Georgia and eastern Alabama. In New England, I found a single male at Wellesley, Mass., in 1891, and have taken it there in small numbers at intervals since. Mr. F. H. Sprague found it at Wal-

pole, Mass., and in 1914 and 1915, I secured specimens at Dover, Mass. These are the only New England localities known, though it probably occurs in Rhode Island and Connecticut, and possibly some of our other States.

It is very local in distribution, although the type of environment which it frequents is of widespread occurrence and covers large areas. It lives among the tufted growth of bunch-grass or "broom-sedge" (*Andropogon scoparius*), on dry, sterile, sandy, or gravelly soil, a background with which its coloration harmonizes singularly well, and it is not likely to be seen without special and even extended search.

It is a sluggish insect, crawling calmly about and hopping weakly when disturbed. The season during which adults have been taken appears to be relatively short, captures having been recorded from July 10 to August 30.

Swamp Locust.

Paroxya clavuliger (Serville).

Figs. 88, 89; Plate 23, figs. 13, 14.

Acridium (Oxya) clavuliger Serville, Orthoptères, p. 676 (1839).
Paroxya atlantica Fernald, Orth. N. E., p. 34 (1888).
Paroxya floridana Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 383, pl. 25, fig. 10 (1897).—Morse, Psyche, vol. 8, p. 296 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 122 (1911).

Of large size and elegant form. Body nearly cylindrical, but slightly compressed. Antennae very long and slender. Head large and eyes prominent in both sexes. Mid-carina of pronotum distinct throughout. Tegmina long and narrow, equalling or falling a little short of end of body. Prosternal spine long, acutely conical or sub-cylindrical, very acutely pointed. Hind femora long, slender, but strong. Cerci long, equalling supra-anal plate, narrow, the apex incurved, flattened, and expanded nearly to the width of the base, often indistinctly bilobed by a slight emargination distally, the upper lobe larger, convexly rounded apically, the lower lobe half as wide, subangulate. The furcula consists of a pair of straight, parallel or divergent, flattened, tapering fingers from broad bases, about as long as last dorsal segment. Subgenital plate very short ventrally, the

dorsal margin thickened, ampliate at base, flaring, convex or truncate behind; below the dorsal margin, the sides are shallowly excavate, passing straight backward to a bluntly rounded submarginal apex.

Olive brown or green above, greenish yellow beneath; femora green; hind tibiae bluish green. Antennae dusky, narrowly

88

89

Fig. 88.—Swamp Locust, *Paroxya clavuliger*. Male. (After Blatchley.)
Fig. 89.—Same. Female. (After Blatchley.)

ringed with pale. Lateral stripe broad, even, black, continuous from eye to base of abdomen below tegmina, sometimes less heavy on metazone of female; below this the whole side of face and body faintly greenish white. Hind knees black.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	20–25	13 –16	12 –13.5	13 –15
Female	26–36	14.5–20	15.3–18.7	8.5–11 mm.

The hind femora usually pass the tegmina by one or two millimeters in the male and two or three in the female.

A few melanic examples have been taken of a peculiar, nearly uniform oily greenish black. These were secured at Faneuil

Station near Boston, Mass., on salt-marsh at the side of the railroad track; the locality has since been destroyed by the march of modern improvements. Whether the color had any relation to the salt-marsh environment, or to carbonaceous matter deposited from the smoke and cinders of trains remains to be determined.

This is a slender-bodied Locust of medium size, graceful form, and elegant appearance which will be readily recognized when captured. It occurs locally in swamps and marshes in southern New England, sometimes on cord-grass (*Spartina*) growing in the tide-water ditches of salt-marshes, sometimes in the tall sedges and rank weeds of bushy inland meadows and swamps. It is usually common but not abundant where found. It is an alert and active Locust but seeks safety in trying to escape observation by sidling around out of sight behind the stouter stems of grasses and weeds rather than by flight, to which it resorts only when closely approached or alarmed. It leaps well and quickly, but its flight is comparatively short.

It inhabits only the warmer, southern part of New England and is a late-maturing species. It has been taken from July 22 to August 30 at Cambridge, Faneuil, Newtonville, and Walpole, Mass.; Deep River, Niantic, North Haven, and Stamford, Ct. Walden reports it also from Branford, New Canaan, New Haven, Westville, and Wallingford, Ct., from August 25 to October 14. Immature examples were plentiful at Faneuil, Mass., on July 22.

Lesser Migratory Locust.

Melanoplus mexicanus atlanis (Riley).

Plate 22, fig. 3–7.

Pezotettix mexicana Saussure, Rev. et Mag. Zool., ser. 2, vol. 13, p. 160 (1861).

Caloptenus atlanis Riley, Ann. Rept. Ins. Mo., vol. 7, p. 169 (1875).

Melanoplus atlanis Fernald, Orth. N. E., p. 33 (1888).—Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 178 (1897).—Morse, Psyche, vol. 8, p. 279 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 117 (1911).

Melanoplus mexicanus atlanis Hebard, Proc. Acad. Nat. Sci. Phila., p. 271 (1917).

Of medium size, the male rather slender; a little compressed. Antennae short, about equal to head and pronotum. Crown of head raised above pronotum. Pronotum depressed at princi-

pal sulcus, the mid-carina distinct only on metazone. Prosternal spine distinctly conical, rather bluntly pointed. Mesosternum strongly protuberant in male, less so but distinctly in female. Mesosternal interspace quadrate or longitudinal in female; longitudinal and much narrowed in male. Tegmina elongate, narrow, usually exceeding hind knees by 2 to 3 mm. Hind femora of graceful outline but strong. Subgenital plate long, upturned, emarginate at tip, the sides of the dorsal margin widened at base. Cerci short, less than twice the width of the base, and subtrapezoidal, the ventral side of apex obliquely excised, the dorsal margin a little concave, apex bluntly rounded, shallowly sulcate, in same plane as base. Ovipositor with scoop of upper valves rather short, angulate at base. Cerci of female short, ovate, sides convex.

Color: dark olivaceous or reddish brown above, greenish yellow to yellow beneath. Hind tibiae and often the under side of the hind femora red; in other examples the hind tibiae are greenish, blue, or either of these colors at base and reddish at tip. Lateral fuscous stripe usually noticeable on head and prozone, but often much broken up and irregular. Tegmina usually with a very distinct median line of dusky spots alternating with pale ones, and numerous smaller dusky flecks near the apex. Metepisternal pale stripe distinct. Hind femora fasciate with oblique dusky bands. Altogether, the dusky markings are decidedly more prominent than in *M. femur-rubrum.*

The hind tibiae are normally red, but in about ten per cent of cases or less they are either reddish at tip and otherwise colored at base, or luteous, glaucous, or bluish. In this respect males seem more variable than females.

Measurements.

	Total	Body	Hind femora	Tegmina	Antenna
Male	20.5–27	17–21.5	10–13	15 –21	7 –8.5
Female	20 –29	16–27	10–14	14.5–22	6.5–8 mm.

The tegmina pass the hind femora from 1.5 to 6 mm., usually about 2 to 3 mm.

The Lesser Migratory Locust is a near relative of the dreaded Rocky Mountain Locust or Grasshopper which devastated the western States in 1875–8, and it has many of the characteristics of its larger relative, including a capacity for multiplying to

a harmful extent that not infrequently manifests itself under suitable conditions. Depredations commonly attributed to the Red-legged Locust are probably often caused by this species. It appears early in the season (June 17 to 21) and continues until late in the fall (November 16). It is found locally over the whole of New England from Nantucket to Canada, from the seashore to the alpine summits of our highest mountains. In the summer of 1913, it was by far the commonest and most generally distributed of any of the genus throughout northern and eastern Maine, at all elevations from the seacoast to the summit of Mt. Katahdin, where it was abundant in the sedge of the tableland. By preference it inhabits sandy and gravelly spots or slopes on light soil, but being active and strong of wing, with a tendency to rove, it may be met with nearly anywhere.

Huckleberry Locust; Banded Locust.

Melanoplus fasciatus (Walker).

Plate 22, figs. 23, 24.

Acridium fasciatum Walker (Barnston MS.), Cat. Dermapt. Salt. Brit. Mus., vol. 4, p. 680 (1870).

Pezotettix borealis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 464 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 149 (1868).—Fernald, Orth. N. E., p. 30 (1888).

Melanoplus rectus Fernald, *ibid.*, p. 32 (1888).

Melanoplus fasciatus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 267, pl. 18, fig. 2–4 (1897).—Morse, Psyche, vol. 8, p. 53 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 119 (1911).

Of medium size and stout build, the short tegmina and the exceptional breadth of the thorax increase the stocky appearance of the insect. The pronotum is short and stout, in side view horizontal above, and the prozone full. The prosternal spine of the male is rather short, cylindrical, and blunt-tipped; of female short and variable, conical or cylindrical with either a conical or a blunt tip. Tegmina and wings variable, usually extending on the hind femora one-half or two-thirds their length; rarely individuals are found with fully developed tegmina and wings. Hind femora notably stout, well rounded in both lateral and vertical views. Abdomen of male strongly upturned at apex, the subgenital plate in side view with lateral margins dilated at base,

sinuate, and apex acute; from above the sides are nearly straight and the apex blunt, convex. Cerci four times as long as middle breadth, nearly straight, tapering on basal third, the distal two-thirds nearly equal in width, ending in a broad, rounded tip which is a little more produced on the ventral side and often somewhat flattened and even grooved, the whole organ very slightly incurved. Furcula reduced to a pair of minute, widely separated tubercles. Ovipositor of female exserted, large, but upper valves lacking angulation at base of scoop.

Color: usually a dark rufous brown above, paling to light red toward end of tegmina. Hind femora conspicuously banded with fuscous at base, apex, and thirds. Hind tibiae bright cherry red throughout, or more or less yellowish or even glaucous at base. Lateral black stripe usually distinct, sometimes nearly obsolete, often cut obliquely on prozone by a pale line. Beneath pale yellowish white or gray. The ground color above sometimes varies to ivory white on head, pronotum, dorsal field of tegmina, and hind femora, producing a conspicuously variegated or banded pattern. This color variety occurs usually in near proximity to open sand areas. I have taken examples of it at Orono, Me., and Provincetown, Sudbury, and West Chop, Mass.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	16 –19	7.5–10.5	9.3–10.7	7.5–9
Female	16.5–25.5	9 –12	10.7–12.7	6.5–8.5 mm.

Long-winged Form.

Total	Tegmina	Wings
22	14.5	16 mm.

This species is usually recognized at once, the cerci of the male being quite distinct from those of any other of our species, and the typical female may be known by the length and attenuated form of the abbreviated tegmina. In the case of the long-winged female and specimens causing doubt, the heavily fasciate femora, the decidedly transverse metasternal interspace, and the prosternal spine—broad at base, conical, with rounded apex,—should remove any uncertainty.

This is a very widely distributed species, from Newfoundland and Labrador southward to the mountains of Alabama and westward to Arkansas, Colorado, Alberta, and Washington. Partly

in consequence of this it has received an unusual number of names, having been called, in addition to those cited, *Melanoplus curtus* in Colorado and *Melanoplus baconi* in Arkansas. The long-winged form was described from Michigan and was not known from New England until I took it at a high elevation on Mt. Katahdin in the summer of 1913. It thus seems to be associated with a cool climate.

While widely distributed, this species is common only locally and is most often met with in dry, sterile, uncultivated land, frequently where it is elevated and rocky, among thickets of huckleberry bushes and similar under-shrubs, on mountain tops and in open pitch-pine woods growing in sandy soil, or about the margins of bogs.

It is a sluggish insect and persistence in search is needed to startle the lurking inmates of a thicket into activity and make them reveal themselves; but when aroused the powerful hind legs enable it to take long leaps in evading pursuit.

Unobtrusive, retiring, living only in the wilder, untilled parts of a wide extent of the country, this Locust in its habits and relation to the wilderness might appropriately receive a name associated with the aboriginal inhabitants.

It matures in June, sometimes before the middle of the month, and may still be seen in September and perhaps in October, though it is probably most abundant in July. Adults are recorded from June 13 to September 5. As may be inferred from previous statements regarding its distribution, it inhabits all of the New England States. I have taken it in various quarters of Maine from sea-level to 4700 feet altitude, on the Provincetown sands, the moors of Nantucket and Martha's Vineyard, and in many other parts of our district.

Red-legged Locust.

Melanoplus femur-rubrum (DeGeer).

Fig. 90; Plate 22, fig. 8–12.

Acrydium femur-rubrum DeGeer, Mém. Hist. des Ins., vol. 3, p. 498, pl. 42, fig. 5 (1773).—Harris, Treatise, 3d ed., p. 173 (1862).

Caloptenus femur-rubrum Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 150 (1868); Rept. Ct. Bd. Agric. for 1872, p. 362 (1873).

Melanoplus femur-rubrum Fernald, Orth. N. E., p. 33 (1888).—Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 278 (1897).—Morse, Psyche, vol. 8, p.

282 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 118 (1911).

Of medium size. Crown of head a little raised above level of pronotum, which is a little depressed at principal sulcus. Mid-carina distinct only on metazone, but often indicated on prozone, usually more noticeable than in *M. m. atlanis*. Mesosternum not protuberant. Prosternal spine cylindrical, with bluntly rounded, almost bulbous tip. Tegmina elongate, narrow, passing hind knees and body usually by two or three millimeters. Last abdominal segment of male enlarged, broad, upturned. Subgenital plate short, rounded, its dorsal margin strongly ampliate at base. Cerci nearly straight, elongate, tapering on basal half, subequal apically, and about half as wide as base, the tip obliquely cut off ventrally. Furcula long, arising from broad bases, at first divergent, then parallel and tapering, half as long as the cerci. Ovipositor of female with scoop of upper valves elongate, rounded, or sub-angulate at base. Cerci of female one and one half times as long as wide, the sides of apex concave.

Fig. 90.—Red-legged Locust, *Melanoplus femur-rubrum*,—the common "Grasshopper." Male. (After Blatchley.)

Dark olivaceous or rusty brown above, olive green to yellow beneath, the hind tibiae and under side of hind thighs bright cherry red. Lateral stripe usually distinct on head and prozone but sometimes much broken up. A median line of dusky spots is nearly always present on the tegmina but these are often extremely faint. Metepisternal pale stripe distinct. The hind femora show remnants of dusky cross bands on the dorsal part of the inner face, and sometimes faint indications are also visible externally.

Measurements.

	Total (average 23–25)	Body	Tegmina	Hind femora	Antenna
Male	18.7–27.5	16–23	13 –20	10.7–13.3	6.5–10
Female	22 –30.7	18–28	15.5–23	11 –15	6.5– 9 mm.

	Tegmina *cf.* Hind fem.
Male	equal – +5
Female	–1 – +5

Though exceedingly numerous and quite variable in size and coloring, no marked varieties occur in this species. The crown of the head and disk of the pronotum are occasionally rose red in color, in both young and adults, and very rarely the hind tibiae are of some other color than red, *e.g.*, yellowish, greenish, or blue,—a pattern more often met with in arid situations in the West. In New England, however, a Locust with hind tibiae otherwise than red may be regarded as almost certain to be of another species than this.

The Red-legged Locust is probably the commonest, most nearly ubiquitous "Grasshopper" found in New England, inhabiting the entire district, and likely to occur in any plat of grass or sedge from seashore to mountain top, at least in the southern and western half. In August, 1913, it was decidedly less abundant and less generally distributed in northern and eastern Maine than *M. m. atlanis*, but whether this condition is usual I am unable to say.

Its adaptability to different conditions of environment is marked, as is shown by its widespread distribution over the greater part of the continent; yet it undeniably shows a preference for the damper parts of open fields, pastures, and wild lands, as compared to the drier portions usually frequented by *M. m. atlanis*.

It matures later than most members of the genus, usually not until late July, and is active until snow falls. Immature examples may be found at least until September, there being apparently great variation in the time of hatching.

The destruction caused from time to time in New England by Locusts is generally ascribed to this species and usually with good reason, though the Lesser Migratory Locust (*M. m. atlanis*) is frequently concerned, and the Clear-winged Locust (*Camnula pellucida*) is open to suspicion, particularly in northern Vermont and New Hampshire. Less often the Two-striped Locust (*M. bivittatus*) becomes destructive locally.

Northern Meadow Locust.

Melanoplus borealis (Fieber).

Plate 22, figs. 13, 14; Plate 23, figs. 5, 6.

Caloptenus borealis Fieber, Lotos, vol. 3, p. 120 (1853).

Melanoplus extremus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 287, pl. 18, fig. 10 (1897).—Morse, Psyche, vol. 8, p. 292, pl. 7, figs. 41, 41a (1898).

Of small to medium size and appearing of short form owing to the brevity of tegmina and wings (in the more common examples). Head and eyes moderately prominent. Prosternal spine of female short, conical, bluntly rounded at tip; of male long, cylindrical, taper-pointed. Pronotum full, horizontal above. Tegmina and wings very variable, equalling the abdomen (♂, ♀), covering only two-thirds (♀), or much surpassing it (♂). Hind femora slender. Subgenital plate of male in side view with dorsal margin sinuous, the hind margin a little flaring, entire, convex, sometimes truncate. Cerci short and broad, not reaching end of supra-anal plate, less than twice as long as broad, roughly trapezoidal, both apical angles rounded, the dorsal more produced, the dorsal margin a little concave. Furcula two-thirds as long as supra-anal plate, two or three times as long as last dorsal segment, the fingers straight, nearly parallel, tapering from broad, flattened bases and united for one-third their length. Ovipositor of moderate length, the dorsal valves in side view lacking an angulation at the base of the scoop. Cerci of female acutely pointed, attenuate, nearly twice as long as broad, more or less variable in length and form but usually approaching those of *M. femur-rubrum* rather than *M. m. atlanis*.

General coloration brownish olivaceous above, paler beneath, with black markings, and often varied with red on hind femora and tibiae. Lateral stripe nearly or quite solid on head and prozone, absent from metazone, much broken on sides of thorax and abdomen, but usually conspicuous in the male, covering sides and end of subgenital plate. Tegmina sometimes with a median row of fine, faint dusky spots. Hind femora not banded. Hind tibiae cherry red, yellowish, or even glaucous, palest at base.

Measurements.

	Total	Body	Tegmina	Teg. *cf.* Hind fem.	Hind femora	Antenna
Male	15–22	15 –19	9.5–16	−3–+3	9.4–11.2	7.5–9
Female ..	16–24	15.5–24	10 –18	−4–+3	10 –12.6	6 –8 mm.

While tegmina of every length between the extremes given are to be found, most individuals fall distinctly into either a short-winged or a long-winged series. The long-winged form seems to be more plentiful at high elevations and in high latitudes. It is quite variable in coloring as well as in wing-length. Typically, its general coloration of olive with black markings is quite characteristic; but the female especially often departs widely from this type and when long-winged resembles *M. femur-rubrum*.

The Northern Meadow Locust makes its appearance early in the season, reaching maturity in late June or early July, and in the White Mountain region is still not uncommon in early September. Like its relative the Red-legged Locust it is partial to cool, moist places and is usually found in the dense, succulent grass of meadows and springy runs, in cold bogs, and among the patches of sedge on the mountain tops. Its flight is like that of the Red-legged Locust but not as prolonged.

It probably inhabits all of Maine except the low, warm southwest corner, as well as the boreal parts of New Hampshire and Massachusetts. Outside of New England, it occurs over a wide extent of Canada, and is recorded from Nebraska, Wyoming, Alaska, and Arctic America. Owing to its only partial occupancy of our territory exact records are of interest:—I have taken it at Cherryfield, Houlton, Mars Hill, Fort Kent, Orono, and Norway, Me.; North Conway, Jackson, Randolph, and various points on Mt. Washington, N. H.; Newport, Troy, Jay, Montgomery, Hyde Park, Woodstock, and the summit of Ascutney Mountain, Vt.; on the top of Mt. Greylock and at Winchendon, Mass. It has also been sent me from Hudson, Me., and Scudder took it in the alpine region of Mt. Washington and Mt. Madison, N. H.

Little Locust.

Melanoplus confusus Scudder.

Plate 22, figs. 15, 16; Plate 23, figs. 3, 4.

Melanoplus confusus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 339 (1897).
Caloptenus minor Scudder, Proc. Boston Soc. Nat. Hist., vol. 17, p. 478 (1875).
Melanoplus minor Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 337, pl. 22,

fig. 9 (1897).—Morse, Psyche, vol. 8, p. 293, pl. 7, figs. 42, 42a (1898). —Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 119, fig. 45 (1911).

This is a species of small or medium size and is rather short-bodied in appearance owing to the brevity of the tegmina and wings. Pronotum horizontal above, prozone full in female. Prosternal spine very variable, long or medium, cylindrical or conical, blunt, acute, or tapering, stout or rather slender, erect or inclined backward. Hind femora stout, plump. Subgenital plate short, its hind margin rounded and thickened, a little protuberant in the midline. Cerci a little exceeding supra-anal plate, with broad, nearly equal base, suddenly narrowed on ventral side to two-thirds the basal width, the tip bent upward and inward, its dorsal margin flattened. Furcula spines of medium length, a little shorter or longer than last dorsal segment, flattened or cylindrical, parallel, well separated. Valves of ovipositor short, little exserted, the tips strongly recurved; the scoop of the upper valves very short, angulate at base.

Color: olivaceous or rufous brown above, yellowish white or pale yellow beneath. The dorsal part of the head, pronotum and all femora is occasionally a bright lake red, sometimes pale tawny; the tegmina are almost invariably spotted with fuscous. Lateral stripe conspicuous on head, prozone, and side of body where it is cut by a distinct oblique white stripe. Hind femora obliquely fasciate on dorsal part of external and internal faces, and clear yellow to cherry red beneath. Hind tibiae very variable, ranging from rose red to sea green or pale blue, frequently being glaucous at base and rosy at tip. Red tibiae are more common among the females (25 to 33 per cent); in the males only 17 to 20 per cent are red.

The female of this species resembles most that of *M. luridus*, from which it can readily be distinguished, however, by the short, angulated scoop of the upper valves of the ovipositor.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	15–18.5	11 –15 average 12 –13	10–11	6.7–7.5
Female	19–24	13.5–18	12–13.5	7 –8 mm.

The body usually reaches about to the end of the hind femora; the tegmina are usually one or two millimeters shorter in the

female and equal in the male, but in one male example they extend two millimeters beyond the hind knees.

I have found this prettily colored and attractive little "Grasshopper" so widespread, plentiful, and conspicuous a species in the field that I have never been able to understand how it escaped notice so long in New England; apparently its presence was entirely unnoted until my first field season in 1891. It is most common on well-drained soil of sandy or gravelly loam, among the grasses (sweet vernal, red-top, Kentucky blue, and timothy) of old mowing-fields which have lain long untilled, in the heavily grassed portions of old bush-grown pastures, or even in the open glades of young forest. It is active, readily taking to wing, but its flight is short, seldom more than three or four yards in length.

It is the earliest member of the genus to appear in spring, adults having been taken June 7. By the 20th to the 25th of the month, according to the weather and the lay of the land, it is quite common, remains so during most of July, and may be found through August and even into September.

It has been recorded from Fryeburg, Me.; Jackson and North Conway, N. H.; Woodstock, Vt.; and many towns in Massachusetts and Connecticut. Extralimitally it inhabits the northern half of the country as far west as Colorado and Montana.

Broad-necked Locust.

Melanoplus luridus (Dodge).

Plate 22, fig. 17–19; Plate 23, figs. 7, 8.

Caloptenus luridus Dodge, Can. Ent., vol. 8, p. 11 (1876).

Melanoplus luridus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 344, pl. 23, fig. 7 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 120 (1911).

Melanoplus collinus Fernald, Orth. N. E., p. 32, fig. 46 (1888).—Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 346, pl. 23, fig. 6 (1897).—Morse, Psyche, vol. 8, p. 294, pl. 7, figs. 43, 43b (1898).

Of medium size and appearing of stout build, due to actual breadth of body and the relatively short tegmina, which reach only to about the end of the hind femora, varying 2 or 3 millimeters either way. The pronotum is short, broad, and decidedly convex longitudinally on the disk of the prozone, the mid-carina usually visible only on the metazone. Prosternal spine

conical, with a blunt point in the female, more acute in male. Tegmina distinctly tapering. Hind femora stout and rather short. Subgenital plate with dorsal margin ampliate at base, the apex truncate, the hind margin thickened. Cerci with a broad, tapering base and furcate distally, the upper branch longer, two-thirds as long as the base and about half as wide; the lower branch acutely pointed, usually but little deflected from axis of base, the upper distinctly deflected upward and a little inward, sulcate near its lower margin, its apex rounded and a little more drawn out on the lower side. Furcula absent or reduced to tiny, well-separated tubercles. Ovipositor little exserted but the tips of the valves long and very acutely pointed, little recurved, the dorsal valves with the outer edge of the basal half of the scoop crenulate or denticulate.

Color: dusky brown above, ranging from rufous to olivaceous, sometimes ferruginous, bright rose, or carmine on head and pronotum; beneath yellow or yellowish green. Lateral stripe usually distinct only in male on prozone and sometimes wanting there. Sides of thorax dusky, crossed by conspicuous dusky pale bar. Tegmina almost invariably marked with fine dusky flecks. Hind femora fasciate with dusky above, clear yellow beneath. Hind tibiae bright red throughout with black spines and pale pubescence, lacking distinct pale or dusky annulus at base.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	16.5–22.5	16.5–20	10.7–16.5	10 –12.5	7 –9
Female	20.5–25.5	19.5–27.5	14 –19	11.5–15	7.5–9.5 mm.

This is one of our later-maturing species: adults appear in late July and August and remain active until the heavy frosts or snow of approaching winter put an end to their existence. One may meet with it almost anywhere, but it is partial to the semi-sylvan conditions furnished by open groves and the edges of deciduous woodlands, especially on rather dry upland soil.

It is more sluggish than the Red-legged or Lesser Migratory Locusts, and with its stocky body and usually dull coloring is a less attractive and interesting species. The males, however, are sometimes very brightly colored and under the rays of the mid-day sun show a considerable degree of sprightliness. In late

autumn particularly, when active insect life is scarce, one meets with pleasure even these dull-colored and stupid creatures basking in the sunshine and hopping sluggishly about, pattering among the withered leaves like falling acorns.

It is distributed throughout all of the New England States and extends far to the south and west. Its exact relationship to its congeners, *M. deletor* and *M. keeleri*, of the South has yet to be determined. The name *M. collinus*, probably selected by Scudder in reference to its stout-necked appearance, and applied originally to New England specimens, must give way according to the law of priority to the older one, *luridus*, proposed for western material, since there are no constant characters distinguishing the one from the other. Rehn and Hebard are inclined to regard this form as conspecific with *M. keeleri* of the South. If this should prove to be the case the name of our New England form would become *M. keeleri luridus*.

Pine-tree Locust; Mottled Locust; Grizzled Locust.

Melanoplus punctulatus (Scudder).

Plate 22, figs. 21, 22; Plate 26, fig. 2; Plate 27.

Caloptenus punctulatus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 465 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 150 (1868).

Melanoplus punctulatus Fernald, Orth. N. E., p. 32 (1888).—Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 374, pl. 25, fig. 4 (1897).—Morse, Psyche, vol. 8, p. 295 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 122 (1911).

Larger than medium, the female appearing rather stout. Head of medium size, eyes large but not especially prominent. Prozone full on disk, metazone flat above, distinctly carinate. Tegmina variable, shorter (♀ only), equalling, or exceeding the hind femora, and rather narrow. Hind femora slender. Prosternal spine short, conical, and dull in female, or slender, sometimes subcylindrical and more sharply pointed in male. Cerci very large, broadly expanded apically to twice the width of base, chiefly on the dorsal side; the apical margin strongly and irregularly convex and somewhat inflexed; the ventral margin nearly straight or concave. Subgenital plate with base of dorsal margin concealed by the cerci, moderately broad, the apex a little upturned and acute or bluntly pointed; rarely in rear view the apical margin

is as broad as the base of the cerci, concave above, and thickened. Furcula reduced to tiny tubercles or absent. Valves of ovipositor dull, little recurved at tip, and the lower lacking the tooth at base.

Color: grayish olivaceous above, mottled with darker, the hind femora conspicuously banded with black and grayish white; beneath greenish gray anteriorly, yellowish posteriorly, inner and under sides of hind femora bright cherry red. Lateral stripe of thorax much broken up. Hind tibiae deep red to gray, with black spines, conspicuously pale-ringed near base, and somewhat darkened above and below this pale ring.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male.....	20.5–25	19–20.5	14 –16.8	10 –11	11 –13
Female	21.5–29	23–29	14.5–21.6	11.3–12.7	10.5–12 mm.

The Pine-tree Locust, though widely distributed in the United States and not uncommon locally, is rare in collections, owing, no doubt, to its habits, which are more arboreal than those of our other species. Coniferous trees, especially pines, are its favorite haunts. In groves of these it may be found either on the ground or on the trunks and branches. Of course, it may occur in very different surroundings. My first specimen was captured in a greenhouse, and I have taken others in open, grassy fields. It is a sluggish insect, and a late-comer as well, adults appearing in late July or August, and it is found through September and October.

I have but once had the good fortune to find it in numbers. Then, the discovery of a populous colony in a pine grove within a few miles of Boston gave me an opportunity to study the species advantageously and secure a series of specimens. One reason for its abundance seems to have been that the grove mentioned had furnished for some time (several years at least) an ample supply of suitable "ground" for the eggs, and this, owing to the peculiar habit of oviposition, is probably quite as essential to the development of a populous colony as abundance of food.

It is a sluggish insect, crawling rather than leaping, relying largely upon its protective coloration to escape notice, and it may usually be picked up by hand before taking alarm. At first glance one might be led to take exception to the statement that its colora-

tion is primarily protective, but such is really the case. When at rest upon the trunks of white-pine trees, which are often grizzled with gray-green lichen thalli and other low forms of plant life, the exposed colors of the insect blend surprisingly well with the background. I have repeatedly gazed for several minutes at an individual basking in the autumn sunshine and only become conscious of others near it by systematic search with eyes and attention attuned to that particular pattern of coloring. It is with a feeling of astonishment in such a case, that one discovers that he has overlooked perhaps a half dozen others equally as conspicuous (or invisible) within a yard of the one first to catch his attention. But the fact remains, and fortunately for him, the Locusts remain also, trustfully waiting for him to pass on.

On a closer approach, they shrink back, sidle away, and finally leap, doubtfully and weakly, owing to their slender legs, to a short distance, rarely, when alarmed, taking several leaps in succession. However, temperature affects their temperament markedly, as with all insects and reptiles, and under sufficient stimulus a considerable degree of activity is shown.

The female Locust, when about to lay her eggs, seeks out some crack or worm-hole in the bark of a dead trunk, thrusts in her abdomen, and places the egg-mass therein, plugging up the hole, or placing the mass on the under side of the bark when it is raised from the wood. (See figures, Plate 27, showing three masses laid from one hole, and in hole of borer in old wood.) I have found three masses thus laid beneath loose bark through one borer exit-hole; others in the cell from which a ribbed pine-borer (*Rhagium lineatum*) had emerged; and another filling up the hole in the wood of the trunk made by some other longicorn larva. The dull form of the ovipositor indicates that this method of using ready-made holes has superseded that of actively excavating them, unless possibly in some soft nidus like that of the decayed wood of stumps and trunks.

Sometimes the hole is plastered over with a brown gummy mass covering the eggs. Oviposition takes place late, as would be expected from the lateness of the species in maturing, in September and October.

This Locust has been taken in Brunswick, Me.; North Conway, N. H.; Vermont; Amherst, Andover, Dover, Sherborn, Waltham,

Wellesley, and Weston, Mass.; Canaan, West Woodstock, and Windsor, Ct., and extralimitally is found in most of the eastern half of the country.

Yellow-striped Locust; Two-striped Locust.

Melanoplus bivittatus (Say).

Plate 22, fig. 20.

Gryllus bivittatus Say, Journ. Acad. Nat. Sci. Phila., ser. 1, vol. 4, p. 308 (1825).

Caloptenus bivittatus Scudder, Boston Journ. Nat. Hist., vol. 7, p. 465 (1862). —Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 150 (1868); Rept. Ct. Bd. Agric. for 1872, p. 362 (1873).

Acrydium flavovittatum Harris, Treatise, 3d ed., p. 173 (1862).

Melanoplus femoratus Fernald, Orth. N. E., p. 32 (1888).—Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 360, pl. 24, fig. 4 (1897).—Morse, Psyche, vol. 8, p. 294 (1898).

Melanoplus bivittatus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 363, pl. 24, fig. 5 (1897).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 121 (1911).

Of large size and robust form. Pronotum broad, prozone of female full. Mid-carina in both sexes indistinct on prozone, distinct on metazone. Tegmina somewhat variable (see measurements). Hind femora long and strong. Hind tibiae stout. Subgenital plate conical, apex rounded, a little elevated, its dorsal margin thickened posteriorly. Cerci roughly sock-shaped, large flat plates two and one-half times as long as basal width. Furcula reduced to short flattened tubercles from tumid bases.

Color: quite different from that of all of our other species, lacking any maculation. Dull olive brown to greenish yellow above, yellow or yellowish green beneath. Usually with a distinct pale stripe on each side of crown of head, continued backward along inner side of position of lateral carinae of pronotum and outer edge of dorsal field of tegmina. Oblique pale stripe on metepisternum distinct, wide. Lateral stripe of pronotum occasionally distinct but usually weak and faint. Hind femora often with indistinct or incomplete dusky transverse fasciae, which are sometimes strongly marked on the dorsal face. Knees, and ring below them, often partly or wholly black. The prevailing olive tint is sometimes replaced by a yellowish or rufous tinge throughout. Specimens dried without preparation become a very dingy brown

in the cabinet, relieved only by the bright-red hind tibiae and tarsi.

Measurements.

	Total	Body	Tegmina	Hind femora	Antenna
Male	23.5–31	23–29	16 –22	12.5–16.5	14 –16
Female	28 –38	29–40	19.5–26	15.5–22	9.6–14 mm.

The ends of the tegmina may fall short of or may pass the hind knees by from 2 to 4 mm. in both sexes.

This is the largest member of the genus inhabiting New England, and is readily recognized. Considerable individual variation in general color exists, there being three well-marked color forms and all intergrades: (1) olive green shaded with brownish fuscous; (2) olive green tinted with lilac or rufous; (3) a bright, pale greenish yellow. Of these the first is most plentiful but typical examples of all three and any number of intergrades may be taken almost side by side. In dried specimens this difference is less noticeable, unless the contents of the body have been removed when first captured. Only the color form with red hind tibiae (*femoratus*) has been found in New England. It extends southward to North Carolina and westward to the Pacific Coast; in the interior the hind tibiae are very variable, yellow, brown, glaucous, red, or all tints at once.

This is a common species throughout New England, inhabiting both coastwise marshes and the alpine summits of the White Mountains; a list of localities is therefore needless. It makes its appearance as an adult late in June or early in July (though young are to be found much later) and is common during most of the season; I have taken it from June 27 till September 20 and it could probably be found until at least the middle of October.

It is most at home among the coarse grasses and weeds of moist meadows, springy runs and swamps, and along the fence-rows of cultivated fields where the growth is rank. Here it sometimes multiplies to such an extent as to become decidedly injurious to crops. In 1916, it did much damage at Dummerston, Vt. The outbreak was checked to a considerable degree by a heavy infestation of nematode parasites.

It is comparatively sluggish and easily captured. Indeed, what child of tender years,—and even of years not tender!—at play in August hayfield or weedy pasture has not coaxed or com-

manded some helpless captive of this burly species to "Give me some molasses!" And always with success,—for the demand is no sooner made than it is honored in generous measure. Not that the smaller Grasshoppers that swarm the fields are less complaisant, but the yield from this one is so much greater—a hogshead to a pipkin—the sticky, treacle-like liquid welling up in such quantity from its capacious maw.

Dawson's Locust.

Melanoplus dawsoni (Scudder).

Fig. 91–93.

Pezotettix dawsoni Scudder, Daws. Rept. Geol. Rec. 49th Par., p. 343 (1875).
Melanoplus dawsoni Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 227(1897).—Morse, Psyche, vol. 8, p. 318 (1898).
Melanoplus scudderi Fogg, Proc. Manchester (N. H.) Inst. Arts and Sci., vol. 2, p. 32 (1901).

Of small size and graceful form. Tegmina abbreviated, equalling pronotum, about one-half as long as the body, narrow, lanceolate, acute or acuminate at tip, their bases barely meeting on the dorsum. Prosternal spine variable in form and length, short to rather long, cylindrical or conical, moderately or decidedly blunt at tip. Hind femora short and slender. End of abdomen of male well upturned; subgenital plate subacute posteriorly, the tip rounded or truncate. Cerci short, scarcely twice as long as their basal width, flattened, curved gently upward, rapidly narrowed dorsally on basal half to about one-third their basal width and well rounded at tip. The furcula consists of a pair of flattened, tapering, parallel fingers a little longer than last dorsal segment, arising from broad tumid bases on the segment.

Color: olivaceous or rufous brown above, clear pale yellow beneath, becoming whiter anteriorly and on the sides. Face and sides of pronotum below lateral black stripe opaque white. Lateral stripe absent on metazone. Sides of body black, irregularly marked with grayish white. Tegmina brownish fuscous, with gray veins. Hind femora fasciate with grayish white on an olive-brown ground, and honey yellow within, shading into red distally. Hind tibiae and tarsi pale red. Female with abdominal segments fuscous at base, gray distally, the last

segments deep yellow beneath, ovipositor yellow; penultimate segment of male abdomen brownish fuscous.

Measurements (from Scudder).

	Body	Tegmina long-winged	Tegmina short-winged	Hind femora	Antenna
Male.....	14.5–16	15	5.25	8.75–9	7–7.5
Female.....	17.5–18.5	16	5.25	10 –10.5	6–6.25 mm.

Specimens with fully developed tegmina and wings occur in the West but have not yet been found in New England.

The history of this species as noted in New England is of unusual interest. In his "Revision of the Melanopli," Scudder recorded an example of *Melanoplus scudderi* from Brunswick, Me., taken by Packard. While preparing an article on the distribution of the New England Locusts I was struck by this apparent exception to the expected range of *M. scudderi*, examined the specimen referred to, and discovered it to be *M. dawsoni*, previously known from Minnesota and farther west. Could it really

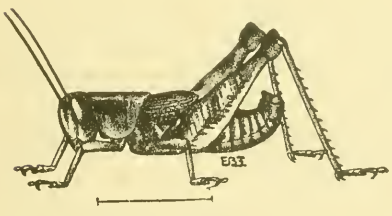

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Fig. 91.—Dawson's Locust, *Melanoplus dawsoni*. Male. (After Lugger.)
Fig. 92.—Same. Male. End of abdomen from above. (After Lugger.)
Fig. 93.—Same. Female. (After Lugger.)

have come from New England or was it a case of accidental mislabeling? There the matter rested until Miss Fogg, studying the Orthoptera of the vicinity of Manchester, N. H., captured two or three specimens of a short-winged Locust which she identified and recorded as *M. scudderi* but which on examination proved to be *M. dawsoni*. Since then I have taken it personally at both localities.

I found it in grass (timothy, bunch-grass, etc.) on sandy soil, in near proximity to low open woods of pitch pine with scrubby undergrowth. Though common in Minnesota and the West, in New England it evidently occurs only as a very scarce and local species whose presence will be detected only by good luck or extreme persistence and thoroughness in collecting. The New England specimens were taken in August and September. In Minnesota it is mature in July and August and disappears shortly after September first.

Smith's Locust.

Melanoplus mancus (Smith).

Plate 22, fig. 28–31; Plate 23, figs. 9, 10.

Pezotettix manca Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 149 (1868). —Fernald, Orth. N. E., p. 30 (1888).

Melanoplus mancus Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 218, pl. 14, fig. 9 (1897).—Morse, Psyche, vol. 8, p. 280 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 115 (1911).

Size small (♂) to medium (♀). Head moderately large and eyes rather prominent in male. Prosternal spine of female conical from a broad base and bluntly rounded at tip, in the male cylindro-conic. Tegmina much abbreviated, broadly and bluntly lanceolate (♂) to subovate (♀), about three-fourths as long as pronotum, attingent or sub-attingent dorsally. Hind femora of moderate size and graceful form. Subgenital plate of male in side view triangular, the sides straight or nearly so, the dorsal margin but slightly shorter than the ventral, often a little concave, the apex acute, rounded at tip; from above, the sides straight, tapering to a bluntly rounded point. Cerci rather long, equalling supra-anal plate, twice as long as width of base, narrowed rapidly on dorsal margin of basal third or half to half the width of base, the distal half or third equal, with sides

parallel, ending in a flattened, externally sulcate, incurved, bluntly rounded, symmetrical tip, which is sometimes a little more produced on the ventral side of the apex; the ventral margin is nearly straight. The furcula consists of a pair of short, narrow, cylindrical, parallel fingers about equal to last dorsal segment, on narrow bases.

Color: in general, dark rufous or smoky brown above, pale grayish or yellowish beneath. The lateral black stripe pronounced, usually nearly solid on the pronotum and continued on sides of thorax and abdomen, cut only by the white metepisternal line. Hind femora not fasciate. Hind tibiae cherry red, sometimes paler at base.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	14–17.5	2–4	8.3– 9	6.5–7
Female	18–25	3–5	10 –12	6.5–7 mm.

This attractive little short-winged Locust was described by Professor S. I. Smith from material secured on Speckled Mt., Stoneham, Me. In search of topotypic material I visited the mountain over twenty years afterward and was successful in finding it without difficulty. Since then I have taken it at Cherryfield, Me.; Pequawket Mt., N. H., 2000 to 3250 ft.; Ascutney Mt., Vt., 3300 ft.; Mt. Everett, Mass., 2600 ft.; Bear Mt., Ct., 2350 ft.; and Kaaterskill High Peak, Catskill Mts., N. Y., 3800 ft. Messrs. S. H. Scudder, Morgan Hebard, and C. P. Alexander have secured it on Mt. Desert Id., Me.; Professor W. S. Blatchley at North Madison and Woodbridge, Ct.; and it is recorded from the highlands of New Jersey.

I have usually found it in the dwarf thickets of blueberry bushes and other species of Vaccinium, on the sterile, rocky, exposed parts of the mountains and the blueberry barrens of Maine, and often in the near vicinity the Wingless White Mountain Locust, but sometimes in much drier surroundings. It is an alert and agile species, when approached springing suddenly and to a distance, sometimes making several leaps in succession.

It probably reaches maturity in late July and early August, adults having been taken from August 8 to September 6. It is apparently very local in distribution, at least in the southern part of its range. Careful search will probably reveal its pres-

ence at numerous other points in the southern half of New England.

Scudder's Short-winged Locust.

Melanoplus scudderi (Uhler).

Plate 22, fig. 25–27.

Pezotettix scudderi Uhler, Proc. Ent. Soc. Phila., vol. 2, p. 555 (1864).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 370 (1873).

Melanoplus scudderi Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 212, pl. 14, figs. 5, 6 (1897).—Morse, Psyche, vol. 8, p. 280 (1898).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 116 (1911).

A little below the medium size, the male small in proportion to the female. Body distinctly compressed. Mid-carina of pronotum visible throughout; lateral lobes nearly as deep as long. Prosternal spine flattened from front to rear, broad, blunt-pointed, round or even truncate at tip. Tegmina about equal to pronotum, broadly lanceolate, acute, acuminate, or rounded at apex. Hind femora plump but of graceful form. Subgenital plate short, conical, with dorsal and ventral margins equal, the ventral slightly concave, the apex smoothly rounded both from above and the side. Cerci two-thirds as long as the supra-anal plate, bluntly triangular, erect, curved a little upward and inward, the tip broadly rounded and externally shallowly and broadly sulcate. Furcula reduced to very short tubercles scarcely as long as last dorsal segment, from tumid bases, parallel, divergent, or inflected. Ovipositor well exserted, with long and very acutely pointed valves.

Color: light to dark rufous or ochraceous brown above, yellow beneath. Lateral stripe distinct in male only, and restricted to prozone. Sides of body pale, lacking fuscous. Hind femora unspotted or showing only traces of bands. Hind tibiae bright red, sometimes paler proximally but without either dark or pale annulus at base. Abdomen pale.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male.....	15–18	4–4.5 av. 5 except. 8–8.5	10–11	6.5–7
Female.....	17–24	5–8 " 6	11–13	6 –7 mm.

Adults of this species have an exceptionally juvenile aspect. This is due to their form and proportions and the relatively dull coloration, which is lacking in effective contrast when compared with other species; and the general aspect is accompanied, curiously enough, by a weak chitinization of the body wall, so that the insect not only looks immature but even feels so! This is especially true of the female.

Scudder's Short-winged Locust is more southern in distribution than our other short-winged species of this genus. It has been taken thus far in New England only in Connecticut and in southern Massachusetts. Beyond our borders it extends to southern Minnesota and southward to Georgia and eastern Texas.

Professor S. I. Smith, at the time residing in New Haven, was the first person to discover this Locust in New England, I believe. At his suggestion, some twenty years afterward, I sought for it in the vicinity of West Rock, in that city, and found it plentiful among the stones and bushes of the talus slope at the foot of the cliff. Afterward, I took it in small numbers at North Haven and Deep River in the southern part of the State, and at South Kent in the western part. Scudder reports it from Springfield, Mass., taken by J. A. Allen; and I have taken it at Wareham.

The dates of capture range from August 19 in Connecticut to November 22 in Indiana. Walden records it as "rather common in the latter part of the season in open places in bushy pastures, on hillsides, or along the edge of woodland." It shows a preference for dry soil rather than damp and in the vicinity of Ithaca, N. Y., is reported from the tops of hills among scattered trees. Blatchley records it as sunning itself on fence rails and the sides of logs in late autumn.

Two locality records for this species that have appeared in scientific literature do not apply to it and are likely to mislead. These are: Brunswick, Maine, Packard in Scudder's "Revision of the Melanopli," p. 214, and Manchester, N. H., Fogg, in Proc. Manchester Inst. Arts and Sciences, vol. 2, p. 32, 1901; both references apply to Dawson's Locust (*q. v.*, p. 516).

Green-legged Locust.

Melanoplus viridipes Scudder.

Fig. 94; Plate 23, figs. 11, 12.

Melanoplus viridipes Scudder, Proc. U. S. Nat. Mus., vol. 20, p. 255, pl. 17, fig. 4 (1897).—Blatchley, 27th Ann. Rept. Dept. Geol. Nat. Resources Indiana, p. 305 (1903).

Of small size and graceful form. Head not large, face decidedly retreating; eyes of male large and prominent, of female medium. Pronotum rather narrow in male, full in female, the disk rounded transversely, on the prozone convex longitudinally in both sexes. Prosternal spine short, conical, usually acutely pointed. Mesosternal interspace strongly transverse. Tegmina a little longer than pronotum, oblanceolate, about twice as long as wide, broadly rounded at apex, attingent dorsally. Hind femora slender. Legs and end of male abdomen covered with pale pubescence.

End of male abdomen strongly upturned. Subgenital plate short, the ventral margin scarcely more than half as long as the dorsal, ending in a delicate upturned tubercle. Furcula reduced to minute, widely separated tubercles. Cerci triangular, about one and two-thirds times as long as width of base, erect, straight, tapering rather regularly to a dull, round tip which rarely is inflected; the ventral margin straight or a little convex, the dorsal margin straight, sinuous, or a little concave near the base.

Fig. 94.—Green-legged Locust, *Melanoplus viridipes*. Male. (After Blatchley.)

General coloration: male, grayish olivaceous above, sides largely black, legs green; of female brownish olivaceous, beneath greenish white, with bases of abdominal segments black. Lateral stripe black, very broad in male, covering two-thirds of the depth of the lateral lobes, one-half of same in female; continuous, but less distinct on metazone of female. Sides of abdomen of male, subgenital plate, and marginal markings of segments black; in female, sides of abdomen black, irregularly marked with gray. Front and middle legs of male bright green, of female greenish fuscous; hind femora green beneath, above gray heavily banded with black, the three basal bands con-

nected ventrally. Hind tibiae green, at base black, pale-ringed, and slightly darkened beyond; spines black.

Measurements.

	Body	Tegmina	Hind femora	Antenna
Male	15–17	5–5.8	9– 9.5	7–8
Female	20–22.5	5–6	10–11	6–7 mm.

This is a variable species, both in coloration and in form of cerci, but the New England examples which I have seen are fairly constant in characters.

This dainty little Locust escaped detection in our territory until Mr. C. W. Johnson, Curator of the Boston Society of Natural History, captured it on the foothills of Mt. Greylock at North Adams, Mass., while engaged in studying the insect fauna of western New England. Since that time he has taken it (and he alone has found it in New England) near Bashbish Falls in southwestern Massachusetts, at Great Barrington, a little farther north; at Manchester and St. Albans, Vt. It will thus be seen that it occurs, so far as known, only in the extreme western part of New England and forms one of the special links biologically uniting that part of our territory with the central States. The nearest point from which it has been reported is Ohio. Apparently it should inhabit much of New York State, and it is probably only a question of attentive search before it will be found there.

One of the main reasons why it so long escaped notice in New England is the fact that it matures very early in the season, dying out in midsummer, and no student of Orthoptera or other person especially interested in the New England insect fauna had collected carefully in that section so early in the season; another reason is that, even if one were captured, it would be extremely likely to be discarded by all but the critical person as an undesirable juvenile specimen owing to its abbreviated tegmina and generally juvenile appearance. It is apparently quite local in its station, also, and not abundant even where found.

Mr. Johnson tells me that it seems to be partial to thickets of raspberry bushes and other low shrubs in pastures, openings in woods, and the edges of woodlands, usually on dry soil; and that the males are active and good leapers, while the females are slug-

gish and quite as likely to be found on the ground as in the bushes. The dates of capture in New England range from June 9 to 28. In Indiana, Professor Blatchley found adults as early as May 11.

Large-headed Locust.

Phoetaliotes nebrascensis (Thomas).

Fig. 95.

Pezotettix nebrascensis Thomas, Ann. Rept. U. S. Geol. Surv. Terr., vol. 5, p. 455 (1872).

Melanoplus phoetaliotiformis Scudder, Proc. Davenport Acad. Sci., vol. 7, p. 179 (1900).

Melanoplus harrisii Morse, Psyche, vol. 16, p. 12 (1909).

Of small size, compressed form, and unusually slender, graceful build. Head exceptionally large, and face unusually retreating. Pronotum narrow, its disk horizontal in longitudinal section, rounding smoothly into lateral lobes at the sides. Tegmina a little longer than pronotum, lanceolate, acute, acuminate at apex, attingent dorsally. Hind femora very slender. The first seven segments of the male abdomen keeled above, the first six strongly so. Apex of abdomen little upturned; subgenital plate short, its ventral margin convex, the dorsal ampliate at base and apex, barely acute-angled in side view, acutely pointed from above. Cercus long, more than twice as long as basal breadth, erect, straight, tapering to a fine, flattened point, the ventral margin straight, the dorsal slightly concave. Furcula reduced to minute widely separated tubercles.

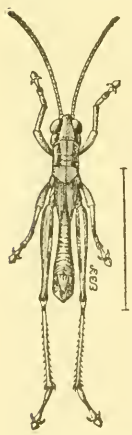

Fig. 95.—Large-headed Locust, *Phoetaliotes nebrascensis*. Male. (After Lugger.)

Color: olivaceous brown above, pale, somewhat leaden beneath, the tegmina brownish fuscous with gray veins. Lateral stripe distinct on head, prozone, and thorax, with very irregular ventral border. Last two dorsal segments and bases of next to last and of several basal segments fuscous. Hind femora intense cherry red apically and within, shading into luteous at base; hind knees black. Hind tibiae very pale glaucous, annulate with black at base, and slightly infuscated apically and at proximal third beneath.

Measurements.

	Body	Tegmina	Hind femora
Male	16	4.5	10.5 mm.

While collecting in an abandoned field in the town of Needham, Mass., August 23, 1908, I secured a single male example of a Locust never before seen in the eastern part of the country but which seemed strangely reminiscent of a Californian species. It was carried home alive, studied for a time, killed and critically compared with pinned specimens of *Melanoplus phoetaliotiformis*, which it resembled very closely, and finally described under the name of *Melanoplus harrisii* in honor of T. W. Harris, the first entomologist to write upon the Orthoptera of Massachusetts.

M. phoetaliotiformis was described by Scudder from material secured by me at Gazelle, Siskiyou County, California (near the base of Mt. Shasta), in the summer of 1897 (see Proc. Davenport Acad. Nat. Sci., vol. 7, p. 179, pl. 7, fig. 9, 1900). He reported it also from Brown's Valley, Traverse Co., Minn., but the occurrence of it or of any form closely resembling it in or near New England is limited to the single specimen mentioned above. Repeated search of the type station in several subsequent seasons has failed to procure additional examples. Could it possibly have been introduced in any way from the West? Recently this name has been placed in synonymy under *Phoetaliotes nebrascensis* which has been taken as far east as Indiana.

The field where this specimen was found is of dry gravelly loam, but undulating and with damp, meadow areas, and at the time was covered with a rather heavy growth of cultivated grasses and weeds running wild, with nothing distinctive about it and no immediate evidence that would indicate importation from a western source of earth containing egg-pods or of other means of introduction. The spot is at least a mile from any railroad and many rods from any house. What the status or distribution of this Locust in New England will prove to be, can only be conjectured.

PYGMY LOCUSTS, GROUSE LOCUSTS—ACRYDIINAE

(Tettiginae).

The Pygmy Locusts (or "Grouse Locusts" as they are sometimes called) are our smallest representatives of the family, and

may be readily known by the prolonged pronotum, which covers the entire body. On account of this character, however, they are likely to be mistaken by the novice for "tree-hoppers" or Membracidae, a family of homopterous bugs, from which the absence of a sucking beak will at once distinguish them.

The elongate pronotum provides protection for the delicate wings, replacing in that function the tegmina, which have been reduced to small oval scales. The wings are usually present and well developed, but in some species are not infrequently reduced in size and rarely are aborted; the length of the pronotum also varies with the size of the wings. Both large- and small-winged individuals occur in the same species, the relative number varying widely. The prosternum projects forward in the shape of a muffler covering the mouth. An important character is the lack of claw-pads (arolia, pulvilli) between the tarsal claws. This is probably connected with the habit of resting on the ground instead of perching on plants, as is indicated by a comparison of the Oedipodine and Acridine Locusts. Another character sharply distinguishing the Pygmy Locusts from the others is the presence of but two segments in the front and middle tarsi. This feature, combined with those already mentioned, *viz.*, peculiar pronotum, rudimentary tegmina, and lack of pulvilli, points to this group as being aberrant and in these particulars more specialized than the other Acridian subfamilies, perhaps even of family rank.

With the probable exception of one Acridine (*Eritettix simplex*) these little Locusts are the only members of our Acridian fauna which hibernate in the adult stage. "On the approach of winter they hide beneath chunks, chips, rubbish, the loose bark of logs, or beneath the bottom rails of old fences. Sometimes a warm sunny day in mid-winter tempts them forth in numbers, and on such occasions the earth seems to swarm with them as they leap before the intruder, their hard bodies striking the dead leaves with a sound similar to that produced by falling hail. If the winter is an open one, with alternate periods of thawing and freezing, many of them doubtless perish. On the first warm days of spring they can be collected by hundreds from any grass-covered hillside having a sunny southern exposure, or from the boggy places along the margins of lakes and streams" (Blatchley,—Indiana).

The coloration is protective, resembling the soil background

in tint, and though often prettily varied, is never such as to make the insect conspicuous in its haunts.

According to Hancock, who has made a special study of the group, they "feed upon the vegetable mold or decomposing soil sometimes mixed with algae, or on the lichens, mosses, tender sprouting grasses, sedges, germinating seeds of plants and débris found in such situations. They are ravenous eaters." Morsels especially prized are found on the surface of variously colored clay soils, and they eat the rich black vegetable mold itself.

"In the middle of May [Illinois] the first eggs are laid in the ground, the female accomplishing this act by making a shallow burrow with her ovipositor. The young larvae, hatched from this brood, mature by fall, passing the following winter in the adult state. The broods hatched in late June and July are often immature by the time winter arrives, and we find them hibernating in the pupa state. The time of incubation varies with the temperature, the early broods of *Tettix* [*Acrydium*] hatching in 23 days, but as the days become warmer this period is shortened to 16 days. The number of eggs of *Tettix* and *Paratettix* varies considerably, but there are more often 10, 13, or 16 in each burrow; in *Tettigidea* varying from 12 to 26" (Hancock).

This is an exceedingly difficult group of insects to study, owing to the fact that individual and local variations overlap geographical and apparently even specific differences. It still needs critical treatment by an experienced systematist based on a large amount of wisely collected material before correct conclusions can be arrived at in regard to the relation of the various forms. Six species are represented in New England, and two or three additional forms. Of the six, three are distinguished without difficulty, representing three genera. The remaining three, belonging to the genus *Acrydium* (*Tettix*), represent as many series of forms whose relation to each other has yet to be determined, and whose identification taxes the judgment of even the expert.

Key to New England Species of Acrydiinae.

(See Plate 24.)

A. Antennae 12- to 14-jointed. Eyes from above not encroached upon by a small convex portion of the crown.

B. Median carina of pronotum high, crest-like, arched longitudinally.

Upper lateral sinus of pronotum shallow, about half as deep as the lower.....Crested Pygmy Locust, *Nomotettix cristatus*, p. 529.

BB. Median carina low; dorsum relatively flat or gently sloping. Upper sinus nearly as deep as lower.

C. Vertex of head from above wider than an eye, projecting beyond eyes, angulate, rounded, or truncate.

D. Vertex prominent, angulate, its median carina not at all or but very slightly and rarely projecting; joints of antennae relatively stout and hind femora slender.

Angulated Pygmy Locust,
Acrydium granulatum granulatum, p. 530.
and
Broad-shouldered Pygmy Locust, *A. g. incurvatum*, p. 531.

DD. Vertex rounded, with projecting mid-carina; joints of antennae relatively slender and hind femora stout.

E. Front of vertex projecting well in advance of eyes, rounded, the mid-carina distinct; disk of pronotum sloping roof-wise (tectiform) at shoulders. Lateral carinae of pronotum typically parallel near front margin.

F. Middle femora of male enlarged, two-fifths or more as wide as long; vertex strongly projecting, with prominent mid-carina; shoulders broad; sides of hind process of pronotum often concave behind humeral angles.

Hancock's Pygmy Locust, *A. hancocki*, p. 533.

FF. Middle femora of male only one-third (or less) as broad as long; vertex less projecting; shoulders narrower; hind process of pronotum with sides typically evenly divergent.

Ornate Pygmy Locust, *A. ornatum*, p. 532.

EE. Vertex projecting but little in advance of eyes, nearly truncate, the mid-carina feebly developed; disk of pronotum nearly flat between the shoulders; lateral carinae of pronotum often converging backward from the front margin; sides of hind process of pronotum usually distinctly concave behind the humeral angles.

Obscure Pygmy Locust, *A. arenosum angustum*, p. 533.

CC. Vertex narrow, about as wide as eye, concave in front, with slight mid-carina.

Hooded Pygmy Locust, *Paratettix cucullatus*, p. 534.

AA. Antennae 22-jointed. Eyes from above distinctly emarginate by crown of head.

Sedge Pygmy Locust, *Tettigidea lateralis parvipennis*, p. 535.

Crested Pygmy Locust.

Nomotettix cristatus (Scudder).

Plate 24, fig. 1–5.

Batrachidea cristata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 478 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 383 (1873).—Fernald, Orth. N. E., p. 48 (1888).

Batrachidea carinata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 479 (1862).—Fernald, Orth. N. E., p. 49 (1888).

Nomotettix cristatus Morse, Psyche, vol. 7, p. 150 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 66 (1911).

Antennae 12- or 13-jointed. Occiput with a pair of small tubercles. Vertex strongly projecting, rounded; mid-carina very prominent; facial costa sharply excised opposite eyes in side view. Pronotum sloping roof-wise (tectiform); its median carina cristate, arched, highest anteriorly, often a little flattened opposite shoulders, the front margin of the disk projecting strongly over the head, the sides of the projection concave.

Color: uniform light or dark gray or brown, the disk often with two or four triangular or more or less crescentic dusky to velvety black spots which are sometimes bordered externally by white, the hind femora often mottled or banded. The variations of pattern are almost endless.

Measurements.

	Total	Pronotum	Hind femora
Male	7.7–11.5	7.1–10.7	4.4–4.8
Female	8.6–12.5	8 –11.3	4.7–5.5 mm.

This curious little Locust is our smallest Acridian and the commonest and most widely distributed Pygmy Locust inhabiting New England. With its peculiarly shaped pronotum it is quite likely to be mistaken by the novice for a tree-hopper and so passed by as a member of an entirely different order of insects.

It is found everywhere on light soils, but especially in dry pastures and other wild land sparsely covered with a scanty growth of curling tufts of Danthonia grass, fragments of Cladonia lichens, and the tough gray leaves of "pussy-toes" and "everlasting" (*Antennaria* sp.). It is perhaps somewhat more plentiful in the damper portions of such localities, but differs much from our other species of the subfamily in this particular, the

others preferring soils perpetually moist or even the shores of lakes and streams. It is not difficult to secure by sweeping, and when plentiful may be picked up readily by hand as it hops erratically about, a foot or two at a leap, tumbling headlong as it falls to the ground.

Adults are most plentiful in April, May, and October, but may be found in any month of the year. It undoubtedly passes the winter in this condition and probably also sometimes in the later nymph stages. It has been taken in every New England State from Ft. Fairfield, Me., to southern Connecticut. Extralimitally the species covers the entire eastern half of the country and develops several geographic races. The caudate or large-winged form apparently occurs throughout its range, but is rare, probably not over five percent of individuals exhibiting this less specialized condition of the wings.

Angulate Pygmy Locust.

Acrydium granulatum granulatum Kirby.

Fig. 96; Plate 24, figs. 13, 14.

Acrydium granulatum Kirby, Fauna Bor.-Amer., Ins., p. 251 (1837).

Tettix granulata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 474 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 382 (1873).

Tettix granulatus Fernald, Orth. N. E., p. 46 (1888).—Morse, Psyche, vol. 7, p. 154 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 68 (1911).

This species is usually recognized without difficulty by its slender form and angulate vertex, which projects well in front of the eyes, sometimes with the apex very slightly rounded, or rarely with the mid-carina indicated. In profile the face is strongly retreating, the facial costa sinuate opposite the eyes and only moderately protuberant opposite the antennae. The pronotum is almost invariably caudate; the disk but little sloping, the lateral carinae parallel in front, the front margin truncate, or very slightly extended, sub-angulate. All the femora are slender.

Color: sides and beneath uniform dark brown; above dark or light brown, uniform or sometimes speckled with dusky dots and often with two or more irregular velvety black marks on the

shoulders. The triangular black marks on the disk above the bases of the hind femora, which are nearly equilateral in the *ornatus* and *arenosus* series are here broader-based, *i.e.*, more extended along the humeral carinae.

Measurements.

	Total	Pronotum	Hind femora
Male	9.7–13.5	8.6–11.5	4.6–5.2
Female	13.5–15.3	12 –13.5	6 –6.5 mm.

The Angulate Pygmy Locust prefers moist meadow lands on sandy ground, soils which are perpetually moist or which do not become unduly hard even when temporarily dried out. The greatest number of the specimens which I have seen were living on the edges of a swamp that had been filled in with sand and upon which the water frequently stood for days at a time. Small areas of this character may support hundreds of these graceful little Locusts, so inconspicuous in size, color, and flight as to attract no notice save by accident or purposeful search, when the sunshine glinting on their iridescent wings, or the presence in the net of stick-like débris apparently endowed with life, leads to their discovery.

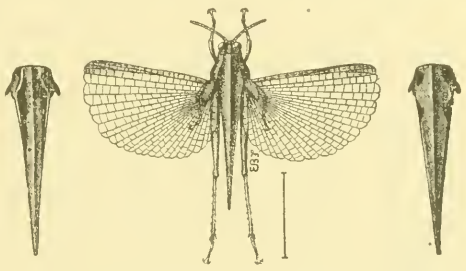

Fig. 96.—Angulate Pygmy Locust, *Acrydium granulatum granulatum*—with wings spread, and two color-varieties. (After Lugger.)

Adults are most numerous in April, May, August, and September and doubtless hibernate. This species inhabits the whole of New England and extends far to the West.

Broad-shouldered Angulate Pygmy Locust.

Acrydium granulatum incurvatum (Hancock).

Tettix incurvatus Hancock, Amer. Nat., vol. 29, p. 761 (1895).

This form, described from the western part of the country, is very closely related to *A. granulatum granulatum* and appears to intergrade with it. Typically, it is distinguished by having

broader shoulders and face, a more sloping pronotum with higher median carina opposite the shoulders, and more sinuate facial profile. A female of this form labeled from the alpine region of the White Mountains is in the Scudder collection. I have also seen three specimens, which probably belong to this form, taken in July at Moosehead Lake (Capens, and Sugar Id.), Me., by Mr. C. W. Johnson.

Ornate Pygmy Locust.

Acrydium ornatum Say.

Fig. 97; Plate 24, fig. 6–10.

Acrydium ornatum Say, Amer. Ent., vol. 1, pl. 5 (1824).

Tettix ornata Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 382 (1873).

Tettix ornatus Fernald, Orth. N. E., p. 46 (1888).—Morse, Psyche, vol. 7, p. 152 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 67 (1911).

The distinguishing characters of this species have already been stated in the key. Long-winged and short-winged examples are about equally numerous. The name *triangularis* was applied by Scudder to the short-winged form of this species (Boston Journ. Nat. Hist., vol. 7, p. 475, 1862).

Fig. 97.—Ornate Pygmy Locust, *Acrydium ornatum*. (After Lugger.)

Color: generally dark brown or grayish, either uniform or varied above with pale brown or white. The pattern is exceedingly variable. There is often a pair of triangular blackish spots on the disk of the pronotum opposite the base of the hind femora, and elongate or crescentic spots in front of them, on a paler ground; sometimes a broad transverse pale band covers the front of the shoulders, giving a 'collared' appearance; sometimes the disk is dark, with narrow white lines bordering the lateral carinae along the humeral angles; or the anterior median portion and the hind process may be pale, with the shoulders marked with intricate patterns of blackish.

Measurements.

	Total
Male	8.3–12.5
Female	9 –13.5 mm.

The Ornate Pygmy Locust is found in wet meadows, but also quite as frequently in damp spots on drier upland soils. It usually occurs in but small numbers, though sometimes a dozen or two may be secured in a favorable locality.

Adults are most common in spring and fall but may be met with at any time during the season, and they doubtless hibernate here since they have been observed to do so in Indiana. *A. ornatum* is found throughout New England and over a wide extent of country to the westward.

Hancock's Pygmy Locust.

Acrydium hancocki (Morse).

Plate 24, fig. 11.

Tettix hancocki Morse, Journ. N. Y. Ent. Soc., vol. 3, p. 200 (1899).—Hancock, Tett. N. A., p. 81 (1902).

The color pattern is much like that of *A. ornatum*, but even more broken up, giving a mottled appearance.

Measurements.

	Total	Pronotum	Hind femora
Male	8.3–13	8–12	5–6 mm.

This robust, broad-shouldered form of the *ornatum* series, described originally from Iowa, has been found in northern New England. I took a single example at Randolph, N. H., July 12, 1898. An example in the Museum of Comparative Zoölogy at Cambridge, Mass., bears the data: "White Mts., N. H., Aug. 15, 1895." It was collected by F. H. Sprague, who frequently visited Randolph and collected there,—so these two specimens may have come from the same locality. I found it in small numbers at Houlton, Fort Fairfield, and Fort Kent, in northern Maine, August 24–28, 1913, in damp spots along roadsides and in fields.

Obscure Pygmy Locust.

Acrydium arenosum angustum (Hancock).

Plate 24, fig. 12.

Tetrix arenosa Burmeister, Handb. d. Ent., vol. 2, p. 659 (1839).
Tettix angustus Hancock, Trans. Amer. Ent. Soc., vol. 23, p. 238 (1900).
Tettix obscurus Hancock, Tett. N. A., p. 87 (1902).

Color pattern resembling that of *A. ornatum*. A variation which sometimes appears in this species consists of a pair of oblique white dashes on the shoulders.

Measurements.

	Total	Pronotum	Hind femora
Male	8.5–12	8 –11.5	5 –5.5
Female	10 –13	9.5–12	5.5–6 mm.

This is a shorter and stouter form of the southern *Acrydium arenosum* (which does not occur in New England so far as known). Short-winged examples of this form are quite likely to be mistaken for the so-called *triangularis* form of the Ornate Pygmy Locust, and the two species quite generally occur together, or at least frequent the same sort of environment,—damp spots on fields of sandy loam, roadsides through springy land, and wet, sandy humus generally.

I have seen numerous specimens taken in different parts of New England, ranging from Cherryfield, Me., and Newport, Vt., in the north, to New Haven, Ct., and Nantucket Island. Extralimitally it is found in most of the eastern half of the country.

Hooded Pygmy Locust.

Paratettix cucullatus (Burmeister).

Fig. 98; Plate 24, figs. 15, 16.

Tetrix cucullata Burmeister, Handb. d. Ent., vol. 2, p. 658 (1838).

Tettix cucullata Scudder, Boston Journ. Nat. Hist., vol. 7, p. 475 (1862).—Smith, Rept. Ct. Bd. Agric. for 1872, p. 382 (1873).—Fernald, Orth. N. E., p. 47 (1888).

Paratettix cucullatus Morse, Psyche, vol. 7, p. 163 (1894).—Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 69 (1911).

Easily distinguished from our other Pygmy Locusts by the form of the vertex: this is barely wider than an eye, scarcely projects beyond their front margin, and is slightly concave, with a small mid-carina. In profile the frontal costa is strongly protuberant opposite the base of the antennae. Eyes large and prominent. Pronotum broad at shoulders, depressed rather than compressed, almost invariably caudate, the front margin truncate, covering the head to the eyes (whence the name

'hooded'); median carina obsolete anteriorly, in side view a little elevated in front of shoulders.

Measurements.

	Total	Pronotum	Hind femora
Male	11 –13.5	9.5–11	5 –5.5
Female	13.5–15.5	11 –13	5.5–6.5 mm.

In color and ornamentation this is one of the least variable of our Pygmy Locusts, resembling closely its surroundings in tint and texture, ranging from pale gray or ochre to a blackish slate color, either uniform or slightly mottled, and often with a pair of triangular dark patches on the shoulders.

It prefers the immediate margin of lakes, ponds, and streams, where it delights to sun itself on projecting stones. When disturbed it flies freely, even for several yards at a time, and often alights on the water, where it swims well.

FIG. 98.—Hooded Pygmy Locust, *Paratettix cucullatus*. (After Lugger.)

In distribution it is somewhat southern and quite local. It has been recorded from various points in all parts of Connecticut, from the vicinity of Boston (Scudder Coll.), and I have taken it on a stony stream-bed at Alstead, N. H. Specimens found on the sandy mud of lake shores at Canaan and Thompson, Ct., were yellowish gray; others from a stream-side at New Haven, strewn with fragments of blackened wood, were so dark as to seem almost black, in both cases so closely matching the background as to be practically invisible.

Adults have been recorded from July 13 to August 29, and young in several stages, even very small, were common at New Haven on the latter date. Its exact life history, and the stages in which it passes the winter, are unknown.

SEDGE PYGMY LOCUST.

Tettigidea lateralis parvipennis (Harris).

Fig. 99; Plate 24, fig. 17.

Acrydium laterale SAY, Amer. Ent., vol. 1, p. 10 (1824).

Tetrix parvipennis HARRIS, Hitchcock's Rept. Geol. Mass., ed. 1, p. 583 (1833).

Tettigidea lateralis Scudder, Boston Journ. Nat. Hist., vol. 7, p. 477 (1862). —Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 383 (1873).—Fernald, Orth. N. E., p. 48 (1888). —Morse, Psyche, vol. 7, p. 164 (1894).

Tettigidea polymorpha Scudder, Boston Journ. Nat. Hist., vol. 7, p. 477 (1862).—Smith, Proc. Portland Soc. Nat. Hist., vol. 1, p. 151 (1868); Rept. Ct. Bd. Agric. for 1872, p. 383 (1873).—Fernald, Orth. N. E., p. 48 (1888).

Tettigidea parvipennis Morse, Journ. N. Y. Ent. Soc., vol. 3, p. 108 (1895). —Walden, Bull. Geol. Nat. Hist. Surv. Ct., no. 16, p. 70 (1911).

Tettigidea lateralis parvipennis Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., p. 150 (1916).

Antennae 22-jointed, but little longer than front femora. Eyes emarginate above by an encroachment of the occiput, which is convex. Vertex projecting considerably in advance of the scarcely prominent eyes, excavate at sides of the median carina, which is very prominent, and which rounds smoothly into the prominent, narrowly grooved facial costa in side view. Face rather strongly retreating. Pronotum distinctly and evenly tectiform (roof-shaped), gently arched longitudinally, the median carina distinct, front margin angulate or rounded-angulate, the hind process either caudate or abbreviate, exceeding the hind knees by two or three millimeters, or falling just short of them, the disk smoothly punctate, often with half a dozen minute longitudinal ridges.

Fig. 99.—Sedge Pygmy Locust, *Tettigidea lateralis parvipennis*. (After Lugger.)

Color: pale buff to dark brown above, the sides darker, often almost black. Face and cheeks, lower half of sides of pronotum, and under side of body white or clay yellow in male, darker in female. A white spot is often present near end of tegmina and sometimes another on the hind femora.

Measurements.

	Total	Pronotum	Hind femora
Male	8.4–13	8 –11.5	5 –5.5
Female	11.5–16.8	10.4–14.6	6.5–7.5 mm.

The Sedge Pygmy Locust lives in wet, sedgy meadows and moist runs, especially on sandy soil, along roadsides through springy land, and in almost every place where there is a constant

supply of moisture and bare soil for the growth of the minute vegetable organisms on which it feeds. Frequently it is associated in its haunts with the Angulate, and sometimes with the Ornate or Obscure Pygmy Locusts.

Though generally met with in but small numbers, a populous colony numbering into the hundreds is occasionally found. The nymphs are common in midsummer, the adults are more plentiful in early fall and again in the spring, and undoubtedly hibernate. It is found throughout New England.

"Nevertheless, when questioned with persistence, those humble creatures with no history can tell us some very singular things."—J. H. Fabre.

ACCENTED LIST OF SCIENTIFIC NAMES

(arranged alphabetically by genus and species).

Acrýdium arenósum angústum
granulátum granulátum
incurvátum
hancócki
ornátum
Amblycórypha floridána carináta
oblongifólia
rotundifólia
Anaxípha exígua
Anisólabis marítima
Árphia sulphúrea
xanthóptera
Atlánticus americánus
testáceus
Blátta orientális
Blattélla germánica
Cámnula pellúcida
Ceuthóphilus brévipes
gracílipes
lapidícola
látens
maculátus
negléctus
terréstris
Chloeáltis conspérsa
Chorthíppus curtipénnis
Chortóphaga viridifasciáta
Circotéttix verruculátus
Conocéphalus brevipénnis
fasciátus
sáltans
spartínae
Diapheroméra femoráta
Dichromórpha víridis
Diestrámmena marmoráta
Dissosteíra carolína
Encoptólophus sórdidus
Epilámpra máya
Eritéttix símplex
Euboréllia annúlipes
Eurýcotis opáca
tibiális
Forfícula auriculária
Gryllotálpa gryllotálpa
hexadáctyla
Gryllus assímilis
Hapíthus vágus
Hesperotéttix brevipénnis
Hippíscus rugósus
Hormética ádvena
Lábia mínor
Leptóphyes punctatíssima
Manoméra blatchléyi
Mántis religiósa
Mecostéthus grácilis
lineátus
platýpterus
Melanóplus bivittátus
boreális confúsus
dáwsoni
extrémus
fasciátus
femur-rúbrum
lúridus
máncus
mexicánus atlánis
punctulátus
scúdderi
virídipes
Nemóbius carolínus
cubénsis
fasciátus
gríseus
maculátus
palústris
Neoconocéphalus énsiger
exíliscanórus
retúsus
robústus
tríops
Neoxábea bipunctáta
Nomotéttix cristátus
Nyctíbora laevigáta
noctívaga

Oecánthus angustipénnis
exclamatiónis
nigricórnis
níveus
píni
quadripunctátus
Orchélimum concínnum
gladiátor
vulgáre
Orphulélla olivácea
pelídna
speciósa
Panchlóra cubénsis
exoléta
Paratenódera sinénsis
Paratéttix cucullátus
Parcoblátta pensylvánica
uhleriána
virgínica
Pardalóphora apiculáta
Paróxya clavulíger
Periplanéta americána
australásiae
Phoetaliótes nebrascénsis
Podísma glaciális
Prolábia aráchidis
Pseudopómala brachýptera
Psinídia fenestrális
Pterophýlla camellifólia
Pycnóscelus surinaménsis
Schistocérca alutácea
rubiginósa
seriális
Scirtética marmoráta
Scuddéria curvicaúda
curvicaúda boreális
furcáta
pistilláta
septentrionális
texénsis
Spharágemon bólli
colláre scúdderi
saxátile
Stagmomántis carolína
Tettigídea laterális parvipénnis
Tridáctylus apiciális
Trimerótropis marítima

GLOSSARY.

Accessory carinae: in Orthoptera, the lateral carinae of the face; supernumerary carinae on the top of head and pronotum in *Eritettix*.

Acuminate: tapering to an acute point with concave sides.

Alutaceous: rather pale leather brown.

Amnion: the inner of the two membranes enveloping the embryo.

Ampliate: broadened, enlarged.

Anal appendages: those borne on the hinder end of the abdomen, including the cerci and genitalia.

Angulate: meeting at an angle, *e.g.*, in the case of two portions of a margin.

Annulate: ringed, banded transversely.

Annulus: a ring or transverse band of color extending entirely around the body or appendage.

Antenna (–ae): a pair of jointed sensory organs borne on the head; the "feelers."

Antennary fossa (–ae); =a. foveolae: grooves on the face between the facial costa and lateral carinae from which the antennae arise.

Appendage: a part, piece, or organ, attached by a joint to the body or other main structure.

Appressed: closely applied to; not diverging at a large angle.

Apterous: lacking wings.

Arcuate: curved like an arc or segment of a circle.

Arenicolous: living in sandy areas.

Armature: the spinous or chitinous processes borne by the body, legs, etc.

Arolium (–a): a fleshy pad beneath the tarsal claws.

Aspect: the direction toward which a surface looks or from which it is viewed.

Attingent: touching; in contact.

Basal: at or toward the base or attachment of; opposed to apical or distal.

Brachypterous: with short, or reduced wings and tegmina.

Cardo: the basal sclerite of the maxilla which connects it with the head.

Carina: a ridge or keel-like elevation.

Castaneous: chestnut-colored; bright reddish brown.

Caudate: prolonged backward like a tail; bearing an elongate, tail-like process.

Cercus (–i): a pair of appendages, homologous with the legs, borne on the sides of the eleventh abdominal segment,—sometimes many-jointed and antenna-like, sometimes unjointed and forceps-like.

Chitin: the horn-like material stiffening the body-wall of insects.

Chordotonal: sensitive to vibrations, applied to the so-called auditory organs of Orthoptera.

Clavate: club-shaped; enlarged toward the tip.

Clypeus: the part of the head below the front, to which the labrum is attached.

Compressed: flattened from side to side.

Costa: an elevated, rounded ridge; the front edge of the wing or tegmen; the most anterior wing-vein.
Cusp: a small pointed projection or process.
Declivent: sloping gradually downward.
Deflexed: bent abruptly downward.
Depressed: flattened dorso-ventrally (from above downward).
Dichromatic: having two markedly different types of coloration.
Dimorphic: having two forms markedly different in structure.
Discal area, disk: the more central part of the wing.
Disk of pronotum: the dorsal surface of the pronotum, above the lateral lobes.
Distad, distal: toward the end farthest from the body, base, or point of attachment.
Dorsal field of tegmina: that portion which lies horizontally on the dorsum or back of the insect.
Dorsum: the entire upper part of the insect body, or body and head.
Ecology: the science of the relation of organisms to their surroundings and to each other.
Egg-guide: a pair of small chitinous processes between the upper and lower valves of the ovipositor in Locusts, = the third pair of gonapophyses, *q. v.*
Emarginate: excised; notched.
Entire: having the outline even, smooth, not notched.
Epicranium: the entire upper part of the head, including face, vertex, crown, occiput, and genae.
Epimeron: the posterior of each pair of lateral sclerites of the meso- and metathorax.
Episternum: the anterior of each pair of lateral sclerites of the meso- and metathorax.
Equal: of the same size, dimensions, or extent; applied either to length, breadth, or termination.
Excavate: hollowed out.
Excised: notched deeply, as if having a piece cut out.
Exserted: protruded; exposed to a considerable degree.
Exuvia (-ae): the cast-off skin of an insect.
Fasciate: banded or streaked transversely.
Fastigium: the tip of the vertex.
Femora, (sing. *femur*): thighs,—the first long segment of the leg.
Fossa (-ae): a groove or channel with sharp edges,—applied particularly to those lodging the antennae.
Foveola (-ae): a shallow depression,—applied to concavities on the sides and top of the head of Locusts.
Furcula: a forked process, sometimes reduced to a pair of tubercles, borne on the hind margin of the tenth dorsal segment of the male abdomen in some Locusts.
Fuscous: brownish black of various degrees of intensity, usually dark.
Fusiform: spindle-shaped; tapering with curved sides toward both ends.
Galea: the outer apical lobe of the maxilla.
Gena (-ae): the cheeks or sides of the head.

Genitalia: the terminal parts of the abdomen used in reproduction, including the appendages, modified segments, copulatory and egg-laying organs.

Glabrous: smooth, faintly shining, free from hairs or pubescence.

Gonapophyses: the three pairs of chitinous processes making up the ovipositor and egg-guide.

Gula: throat; the ventral sclerite of the head, bounded in front by the submentum, on the sides by the genae, and extending to the hinder margin of the head.

Habitat: the entire region naturally inhabited, or the particular type of environment characteristically inhabited, by an organism.

Habitus: the general aspect or appearance.

Halophile (-ous): salt-loving; restricted to salt-marshes or the proximity of the sea.

Hind process of pronotum: the backward-projecting part of the disk or upper surface of the pronotum.

Humeral carinae of pronotum; humero-apical c.: in some Acrydiinae arise on the disk of the pronotum and run backward, forming the dorso-lateral angles of the hind process.

Imago: the adult or fully mature insect.

Immaculate: lacking spots or marks.

Infra-cercal plates: the podical plates, *q. v.*

Infuscated: more or less tinged with dusky or black.

Inner: toward the center, or median plane, *e.g.*, the inner face of the leg.

Insertion: the point or place where a part is inserted or attached, *e.g.*, antennae or legs.

Intercalary: added, or inserted between others, *e.g.*, intercalary vein.

Internal: inner, toward the median plane.

Interspace: the median space lying between the posterior lobes of the mesosternum and metasternum and occupied by parts of the metasternum and first abdominal segment respectively.

Joint: a segment or part between two movable articulations; a movable union or articulation between two consecutive parts.

Jugular sclerites: small sclerites in the membrane connecting the head and thorax.

Knee: the point of junction of femur and tibia.

Labium: the lower lip; the fused 'second maxillae'; a compound median organ on the ventral side of the head.

Labrum: the upper lip; a median sclerite attached to the clypeus and covering the base of the mandibles.

Lacinia: the inner apical lobe of the maxilla.

Lanceolate: lance-shaped; tapering to a point apically.

Lateral carinae of head: ridges on the face extending downward from the eyes.

Lateral carinae of pronotum: ridges separating the disk from the lateral lobes of the pronotum; usually distinct in the Slant-faced Locusts, more or less vestigial in the Band-winged and Spine-throated groups.

Lateral lobes (of pronotum): the deflexed sides of the pronotum below the lateral carinae.

Lower margin: sometimes applied to the anterior or costal margin of the tegmina in Orthoptera, in which it is ventral in the resting position.

Luteous: yellowish; the color of honey; clay yellow.

Macropterous: having fully developed wings.

Maculate: spotted with figures of some size and of a color differing from the background.

Mandibles: the anterior or upper lateral jaws of a chewing insect.

Maxilla (-ae): the second pair of jaws of a chewing insect: 'second maxillae' = labium, = third pair of jaws.

Median carina: usually applied to the median ridge of the pronotum.

Melanism: an abnormal suffusion with blackish.

Mentum: a median sclerite of the labium.

Mesial: median; refers to the median plane of the body or an appendage.

Mesonotum: the dorsal part of the middle or second portion of the thorax.

Mesosternal lobes: the lateral portions of the mesosternum, separated in the median line (m. interspace) by a forward-projecting part of the metasternum.

Mesosternum: the mid-ventral sclerite of the middle portion of the thorax.

Mesostethium: the entire ventral aspect of the mesothorax. "Mesostethium and metastethium together" include "the whole ventral aspect of the mesothorax and metathorax as seen from below, regardless of limitations of sclerites."—*t.* Scudder.

Metanotum: the dorsal part of the third or hinder portion of the thorax.

Metastethium: see mesostethium.

Metazona or metazone: the dorsal surface of the pronotum behind the principal sulcus.

Metepisternum: episternum of the metathorax, the more anterior of the lateral sclerites of that segment.

Molt, moult: the act of shedding the skin or external layer of the body-wall, marking the change from one stage of the insect to the next; the cast-off skin thus shed.

Mouth-parts: a term applied to the movable structures around the mouth, used in eating.

Notum: the dorsal or upper surface, applied either to a segment or to the entire body.

Nymph: a term applied to the immature stages of insects with incomplete metamorphosis. The last stage, showing conspicuous wing-pads, is frequently but erroneously called a pupa.

Obconic: conical with the large part apical.

Occiput: the dorsal hinder part of the head.

Ocellus (-i): a simple eye; these vary from one to three in number in adult insects and are usually placed in front of and between the compound eyes.

Ochraceous: brownish yellow of various shades.

Oötheca: the horny capsule containing the eggs of Cockroaches.

Operculum: a spoon-shaped sclerite beneath the eighth segment of the abdomen of Walking-sticks.

Pagina: the central portion of the outer face of the hind femora, showing a herring-bone pattern of sculpture due to the muscle impressions.

Pallium: the membrane closing dorsally the cavity formed by the subgenital plate.

Palp (*–us*)*:* pl. *palps* (*–i*)*:* jointed, antenna-like appendages of the maxillae and labium.

Percurrent: continuous and complete.

Piceous: lustrous pitchy black.

Pleura (sing. *–on*)*:* the sides of the thorax and abdomen; the lateral sclerites of the thorax between the terga and sterna.

Podical plates: the latero-dorsal plates underlying the cerci and attached to the tenth tergum of the abdomen.

Praescutum; prescutum: the anterior or first of the four divisions of the notum of each thoracic segment.

Pregenicular annulus: a band of color on the hind femora a little before the knee-joint.

Principal sulcus: the suture between the third and fourth divisions of the pronotum, dividing it into prozone and metazone, often marked by a deep notch where it crosses the median carina.

Prismatic: shaped like a prism in section.

Process: a prolongation of or protuberance from a margin or surface.

Produced: extended, prolonged.

Pronotal carina: the median carina of the pronotum.

Pronotum: the dorsal part of the prothorax.

Prosternal spine: a prominence between the front legs arising from the prosternum.

Prothorax: the anterior segment of the thorax.

Proximad, –al: toward the basal or proximal end or the point of attachment.

Prozona, prozone: the dorsal surface of the pronotum in front of the principal sulcus.

Pulvillus (*–i*)*:* fleshy pads beneath the tarsal segments and claws.

Punctate: bearing point-like impressions or dots of color.

Pygidium: see Forficulidae, note.

Quadrate: four-sided, rectangular, nearly square.

Quiescent: not active,—said of the pupa in most forms with complete metamorphosis.

Race: a variety of a species which possesses distinctive characters of less than specific value, usually intergrading with other races or the typical form of the species, and often differing in geographical distribution.

Raptorial: formed for seizing prey.

Reticulate: having a pattern like net-work.

Saxicolous: frequenting rocky or stony areas.

Scapular area of pronotum: in certain Acrydiinae a narrow triangular or linear area on the disk of the pronotum between the lateral and humero-apical carinae.

Sclerite: a stiffened or hard portion of the body wall.

Scoop: a concavity formed by the recurved tips of the ovipositor of the female Locust which aids in removing loosened earth when laying the eggs.
Scrobes: the pits in which the antennae are attached to the head.
Scutellum: the third dorsal sclerite of the thoracic segments (usually compounded with *pro-*, *meso-*, and *meta-*).
Scutellum of vertex: a depression on top of the vertex of the head.
Second maxilla: sometimes applied to the labium.
Segment: one of the ring-like divisions of the body or appendages.
Serrate: toothed like a saw, the teeth pitched toward one end.
Setaceous: bristle-like, tapering to a fine point.
Sinuate: wavy; winding in S-like curves,—applied to lines and margins.
Sinus: a hollow or excavation, *e.g.*, the sinuses of the pronotum of Acrydiinae (Plate 24, figs. 1, 7).
Somite: a segment of the body.
Speculum: a transparent area in the tegmina of some male Orthoptera; it is probably connected with sound-production.
Spindle-shaped: tapering with symmetrically convex sides toward both ends.
Spinose: bearing spines.
Spiracles: the openings or breathing-pores on the sides of the insect body through which air enters the tracheae.
Spurious veins: supernumerary vein-like thickenings in the tegmina or wings, likely to be mistaken for the regular veins.
Stigmata: sometimes used for spiracles.
Stipes: a large sclerite of the maxilla.
Stridulation: the production of sounds by rubbing or striking together roughened surfaces.
Sub-: a prefix meaning 'less than,' 'under,' or 'before.'
Subgenital plate: the last ventral sclerite of the abdomen.
Sulcate: grooved, channeled.
Sulcus: a groove or channel.
Supra-anal or *sur-anal plate:* the last dorsal plate of the abdomen.
Suture: a narrow line, often impressed, marking the junction of sclerites.
Synonym: a name applied to a species or genus which has been named and described before.
Tarsus (*–i*)*:* the terminal, jointed portion of the leg, distad of the tibia.
Tawny: a rufous brownish yellow.
Tectiform: roof-shaped; slanting downward on both sides.
Tegmen (pl. *tegmina*)*:* the anterior wing, = wing-cover, of Orthoptera.
Terga; tergites: the dorsal sclerites of the insect body behind the head.
Tergum: the entire dorsal surface of an insect, or of a segment of the body.
Thamnophile, –ous: thicket-loving,—said of species living in thickets, either woody or herbaceous.
Thorax: the second or intermediate region of the insect body, bearing the wings and the true or jointed legs.
Tibia: the shank, or second long joint of the leg, between the femur and the tarsus.

Trachea (*-ae*): minute tubes conducting air from the spiracles to all parts of the insect body.

Transverse: having the largest dimension at right angles to the main axis.

Trophi: the movable parts surrounding the mouth.

Truncate: cut off squarely at the end.

Tympanum: the external membrane covering the sensory organ on each side of the basal segment of the abdomen of Locusts; sometimes applied also to those on the front tibiae of the Tettigoniidae.

Unicolor: of one color throughout.

Upper margin of tegmina: sometimes but unwisely applied to the inner or posterior margin of the tegmina in Orthoptera which is uppermost or dorsal in the resting position.

Valves (of ovipositor): the four chitinous pieces making up the ovipositor, prominent in Tettigoniidae and most Gryllidae, less so in Acrididae, and not evident in Mole-crickets.

Veins: the rod-like stiffenings of the tegmina and wings, chiefly longitudinal in direction.

Velum: = pallium; the membrane closing dorsally the cavity of the subgenital plate.

Venter: the under surface of the body or of a single segment.

Vertex: the anterior dorsal part of the head between and in front of the eyes.

Vestigial: reduced in size; degenerate; existing as remnants of a previously functional organ.

Wing-pads: the undeveloped wings of the nymph or pupa.

Wings: the organs of flight, including the anterior pair or wing-covers.

Xerophile; -ous: living in dry places.

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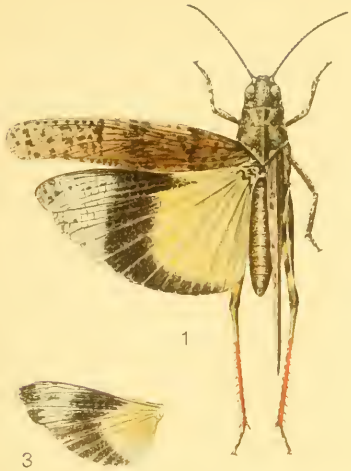
EXPLANATION OF PLATES.

PLATE 10.

All figures about natural size.

Fig. 1. Ledge Locust, *Spharagemon saxatile*. Female. Left wings spread.
Fig. 2. Autumn Yellow-winged Locust, *Arphia xanthoptera*. Left wings spread.
Figs. 3, 4, 5. Sand Locust, *Psinidia fenestralis*. Three wings to show variation in color of disk.
Fig. 6. Coral-winged Locust, *Pardalophora apiculata*. All wings spread.
Fig. 7. Seaside Locust, *Trimerotropis maritima*. Female, left wings spread.
Fig. 8. Same, last-stage nymph.
Fig. 9. Marbled Locust, *Scirtetica marmorata*. Male, pale color-variation.
Fig. 10. Same, female, red color-variation.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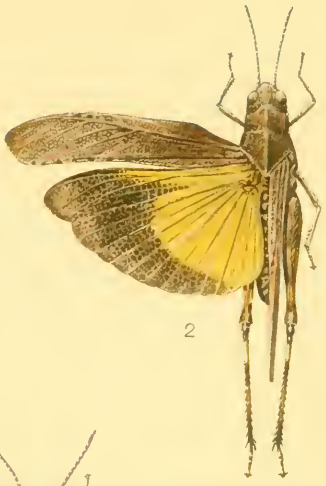
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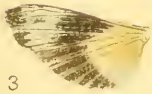
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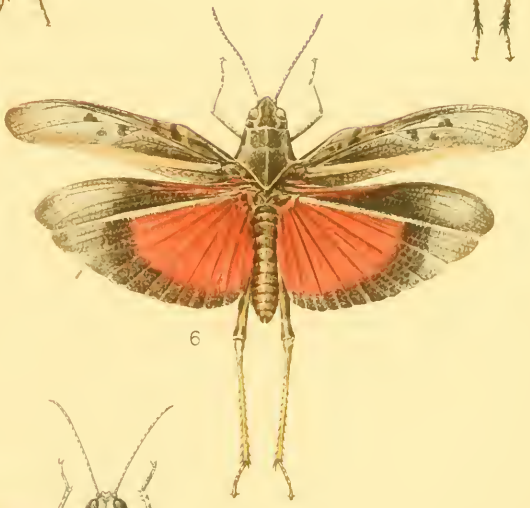
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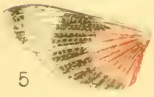
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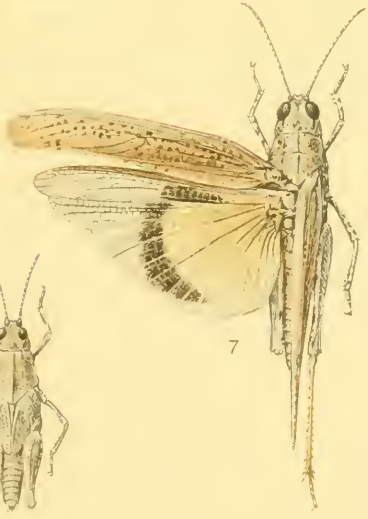
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PLATE 11.

Fig. 1. Purple-striped Locust, *Hesperotettix brevipennis*. Female. × 1½.
Fig. 2. Same, male. × 1½.
Figs. 3, 4, 5. Pasture Locust, *Orphulella speciosa*. Female, three color-varieties. Nearly twice natural size.
Fig. 6. Wingless Mountain Locust, *Podisma glacialis*. Male. × 1¼.
Fig. 7. Same, female. × 1¼.
Fig. 8. Same, female. From beneath. × 1¼.
Fig. 9. Striped Sedge-locust, *Mecostethus lineatus*. Female. × 1⅙.

1

3

4

5

7

6

8

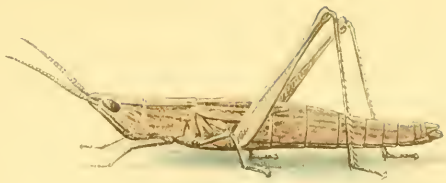
2

9

PLATE 12.

All figures about $1\frac{1}{3}$ times natural size.

Fig. 1. Bunch-grass Locust, *Pscudopomala brachyptera*. Female.
Fig. 2. Rusty Locust, *Schistocerca alutacea*. Male, striped olivaceous form.
Fig. 3. Green-striped Locust, *Chortophaga viridifasciata*. Male, brown form.
Fig. 4. Same, female, green form.
Fig. 5. The Sword-bearer, *Neoconocephalus ensiger*. Female, green form.
Fig. 6. Same, female, brown form.



1

2

3

4

5

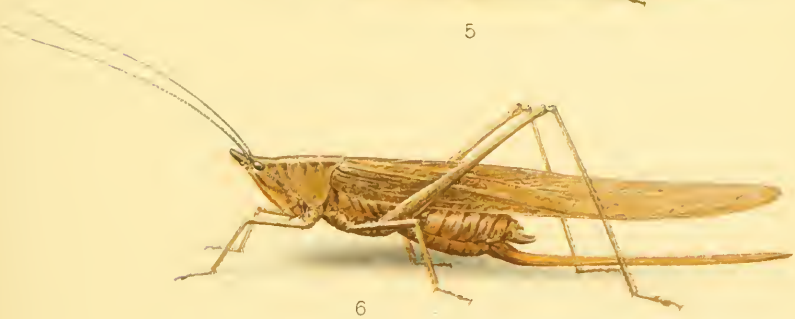


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PLATE 13.

Earwigs and Walking-sticks: Details.

Fig. 1. European Earwig, *Forficula auricularia*. Male. Dorsal view. × 2.
Fig. 2. Same, male, short forceps, dorsal view. × 3.
Fig. 3. Same, male, long forceps, dorsal view. × 3.
Fig. 4. Same, female, forceps, dorsal view. × 3.
Fig. 5. Same. Right middle tarsus, side view. × 14.
Fig. 6. Little Earwig, *Labia minor*. Male. Forceps, dorsal view. × 14.
Fig. 7. Same, male, forceps from left side. × 13.
Fig. 8. Same, female, forceps from above. × 14.
Fig. 9. Same. Antenna, basal joints. × 14.
Fig. 10. Brown Earwig, *Prolabia arachidis*. Female. Antenna, basal joints. × 14.
Fig. 11. Same, male, forceps from beneath. × 11.
Fig. 12. Maritime Earwig, *Anisolabis maritima*. Male. Forceps, dorsal view. × 8.
Fig. 13. Same, female, forceps, dorsal view. × 8.
Fig. 14. Same. End of antenna. × 14.
Fig. 15. Ring-legged Earwig, *Euborellia annulipes*. End of antenna. × 14.
Fig. 16. Blatchley's Walking-stick, *Manomera blatchleyi*. Female. End of abdomen from above. × 4.
Fig. 17. Same, female, end of abdomen, side view. × 4.
Fig. 18. Same. Micropylar end of egg, greatly magnified.
Fig. 19. Common Walking-stick, *Diapheromera femorata*. Micropylar end of egg, greatly magnified.
Fig. 20. Same, female, end of abdomen, dorsal view. × 4.
Fig. 21. Same, female, end of abdomen, side view. × 4.
Fig. 22. Same, male, end of abdomen, dorsal view. × 4.

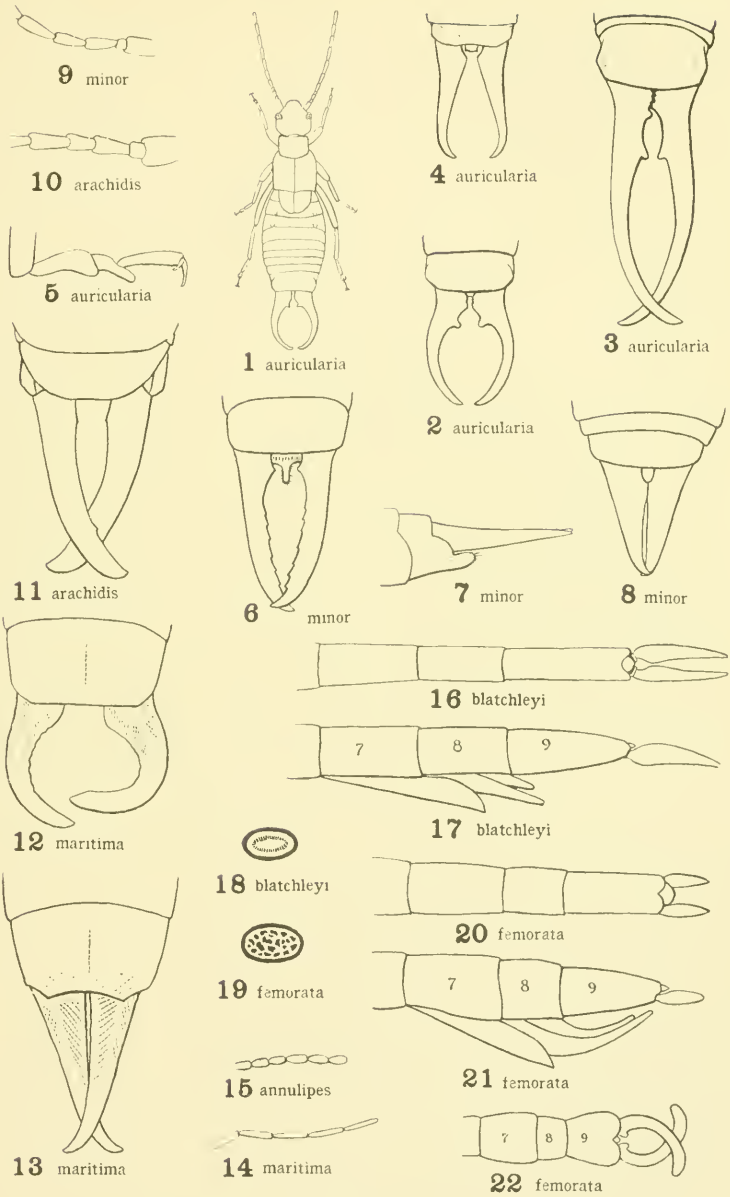

9 minor
10 arachidis
5 auricularia
11 arachidis
12 maritima
13 maritima
1 auricularia
6 minor
18 blatchleyi
19 femorata
15 annulipes
14 maritima
4 auricularia
2 auricularia
7 minor
16 blatchleyi
7 8 9
17 blatchleyi
20 femorata
7 8 9
21 femorata
7 8 9
22 femorata
3 auricularia
8 minor

PLATE 14.

Tettigoniidae: Details of structure.

Fig. 1. Oblong-winged Katydid, *Amblycorypha oblongifolia*. Male. Lateral outline of pronotum, tegmen, and exposed wing. × ½.
Fig. 2. Round-winged Katydid, *A. rotundifolia*. Male. Lateral outline of pronotum, tegmen, and exposed wing. × ½.
Fig. 3. Northern Bush-katydid, *Scudderia septentrionalis*. Male. Supra-anal plate, dorsal view.
Fig. 4. Same, female. Ovipositor, side view.
Fig. 5. Pistillate Bush-katydid, *S. pistillata*. Female. Ovipositor, side view.
Fig. 6. Curve-tailed Bush-katydid, *S. curvicauda*. Female. Ovipositor, side view.
Fig. 7. Northern Curve-tailed Bush-katydid, *S. c. borealis*. Female. Ovipositor, side view.
Fig. 8. Texan Bush-katydid, *S. texensis*. Female. Ovipositor, side view.
Fig. 9. Fork-tailed Bush-katydid, *S. furcata*. Female. Ovipositor, side view.
Fig. 10. Same, male, supra-anal plate, dorsal view.
Fig. 11. Short-legged Shield-backed Grasshopper, *Atlanticus testaceus*. Male. Outline of disk of pronotum and tegmina. × 1½.
Fig. 12. Same, female.
Fig. 13. Same, male, left cercus.
Fig. 14. Same, female, subgenital plate.
Fig. 15. Long-legged Shield-backed Grasshopper, *Atlanticus americanus*. Male. Outline of disk of pronotum and tegmina. × 1½.
Fig. 16. Same, male, left cercus.
Fig. 17. Same, female, subgenital plate.
Fig. 18. Conservatory Camel-cricket, *Diestrammena marmorata*. Spinulation of hind tibiae.
Fig. 19. Same, outline of vertex of head from above.
Fig. 20. Yellow Cave-cricket, *Ceuthophilus neglectus*. Male. End of abdomen, dorsal outline.
Fig. 21. Same, rear view of eighth abdominal tergum.
Fig. 22. Same, rear view of subgenital plate.
Fig. 23. Same, side view of subgenital plate.
Fig. 24. Spotted Cave-cricket, *Ceuthophilus maculatus*. Male. End of abdomen, dorsal outline.
Fig. 25. Same, rear view of subgenital plate.
Fig. 26. Woodland Cave-cricket, *Ceuthophilus terrestris*. Male. Rear view of subgenital plate.
Fig. 27. Same, side view of subgenital plate.
Fig. 28. Pale-footed Cave-cricket, *Ceuthophilus lapidicola*. Male. End of abdomen from above.
Fig. 29. Same, rear view of subgenital plate.
Fig. 30. Same, side view of subgenital plate.
Fig. 31. Short-legged Cave-cricket, *Ceuthophilus brevipes*. Male. Outline of last dorsal segments of abdomen.
Fig. 32. Same, outline of subgenital plate from rear.

Fig. 1–17, after Rehn and Hebard. Fig. 20, 23–30, after E. M. Walker.
Figs. 18, 19, 21, 22, 31, 32, original.

1 oblongifolia
2 rotundifolia
3 septentrionalis
4 septentrionalis
5 pistillata
6 curvicauda
7 borealis
8 texensis
9 furcata
10 furcata
11 testaceus
12 testaceus
13 testaceus
14 testaceus
15 americanus
16 americanus
17 americanus
18 marmorata
19 marmorata
20
21
neglectus
22 neglectus
23
24 maculatus
25 maculatus
26 terrestris
27 terrestris
28 lapidicola
29 lapidicola
30 lapidicola
31 brevipes
32 brevipes

PLATE 15.

Tettigoniidae: Details of structure.

Fig. 1. Robust Cone-head, *Neoconocephalus robustus*. Male. Lateral view of fastigium.
Fig. 2. Same, male, ventral view.
Fig. 3. Same, female, lateral view.
Fig. 4. Same, female, ventral view.
Fig. 5. Round-tipped Cone-head, *Neoconocephalus retusus*. Male. Fastigium, lateral view.
Fig. 6. Same, ventral view.
Fig. 7. Same, male, lateral view.
Fig. 8. Same, male, ventral view.
Fig. 9. Same, female, lateral view.
Fig. 10. Same, female, ventral view.
Fig. 11. The Sword-bearer, *Neoconocephalus ensiger*. Male. Fastigium, lateral view.
Fig. 12. Same, male, ventral view.
Fig. 13. Same, female, lateral view.
Fig. 14. Same, female, ventral view.
Fig. 15. Same, dorsal view.
Fig. 16. Dorsal view of fastigium of Round-tipped Cone-head, *N. retusus*.
Fig. 17. Dorsal view of fastigium of Robust Cone-head, *N. robustus*.
Fig. 18. Dorsal view of fastigium of Unmusical Cone-head, *N. exiliscanorus*.
Fig. 19. Lateral view of fastigium of same. Male.
Fig. 20. Ventral view of fastigium of same. Male.
Fig. 21. Lateral view of fastigium of same. Female.
Fig. 22. Ventral view of fastigium of same. Female.
Fig. 23. Bruner's Meadow-grasshopper, *Orchelimum gladiator*. Outline of pronotum in side view.
Fig. 24. Same, dorsal outline of left cercus.
Fig. 25. Same, lateral outline of left cercus.
Fig. 26. Same, lateral outline of ovipositor.
Fig. 27. Common Meadow-grasshopper, *Orchelimum vulgare*. Lateral outline of pronotum.
Fig. 28. Same, left cercus, from above.
Fig. 29. Same, left cercus, from side.
Fig. 30. Same, ovipositor.
Fig. 31. Dusky-faced Meadow-grasshopper, *Orchelimum concinnum*. Lateral outline of pronotum.
Fig. 32. Same, left cercus from above.
Fig. 33. Same, left cercus from side.
Fig. 34. Same, ovipositor.
Fig. 35. Short-winged Meadow-grasshopper, *Conocephalus brevipennis*. Male. Outline of left cercus from above.
Fig. 36. Salt-marsh Meadow-grasshopper, *Conocephalus spartinae*. Same.
Fig. 37. Slender Meadow-grasshopper, *Conocephalus fasciatus*. Same.
Fig. 38. Wingless Prairie-grasshopper, *Conocephalus saltans*. Same.

Fig. 1–14, 19–34, from Rehn and Hebard. Fig. 15–18 from Walden.
Figs. 35, 36 after Fox. Figs. 37, 38, original.

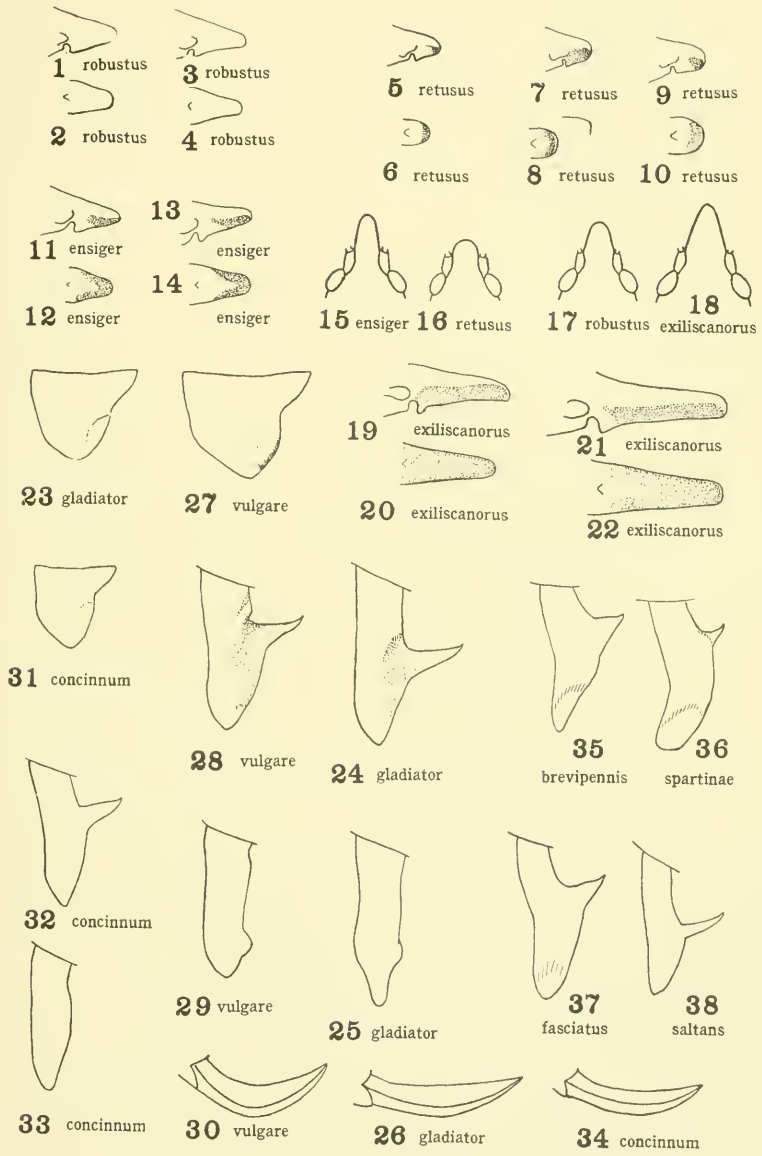

1 robustus
3 robustus
2 robustus
4 robustus
5 retusus
7 retusus
9 retusus
6 retusus
8 retusus
10 retusus
11 ensiger
13 ensiger
12 ensiger
14 ensiger
15 ensiger
16 retusus
17 robustus
18 exiliscanorus
23 gladiator
27 vulgare
19 exiliscanorus
20 exiliscanorus
21 exiliscanorus
22 exiliscanorus
31 concinnum
28 vulgare
24 gladiator
35 brevipennis
36 spartinae
32 concinnum
29 vulgare
25 gladiator
37 fasciatus
38 saltans
33 concinnum
30 vulgare
26 gladiator
34 concinnum

PLATE 16.

Fig. 1. Sand Cricket, *Nemobius griseus*, male.
Fig. 2. Same, female.
Fig. 3. Striped Grass-cricket, *Nemobius fasciatus*, female.
Fig. 4. Same, female.
Fig. 5. Carolina Ground-cricket, *Nemobius carolinus*, male.
Fig. 6. Same, female.
Fig. 7. Little Spotted Ground-cricket, *Nemobius maculatus*, male.
Fig. 8. *Nemobius confusus*, female. (Extralimital.)
Fig. 9. Carolina Ground-cricket, *Nemobius carolinus*, male.
Fig. 10. Same, female.
Fig. 11. Sphagnum Cricket, *Nemobius palustris*, male.
Fig. 12. Same, female.

From E. M. Walker, "The Crickets of Ontario." Can. Ent., vol. 36, pl. 4 (1904).

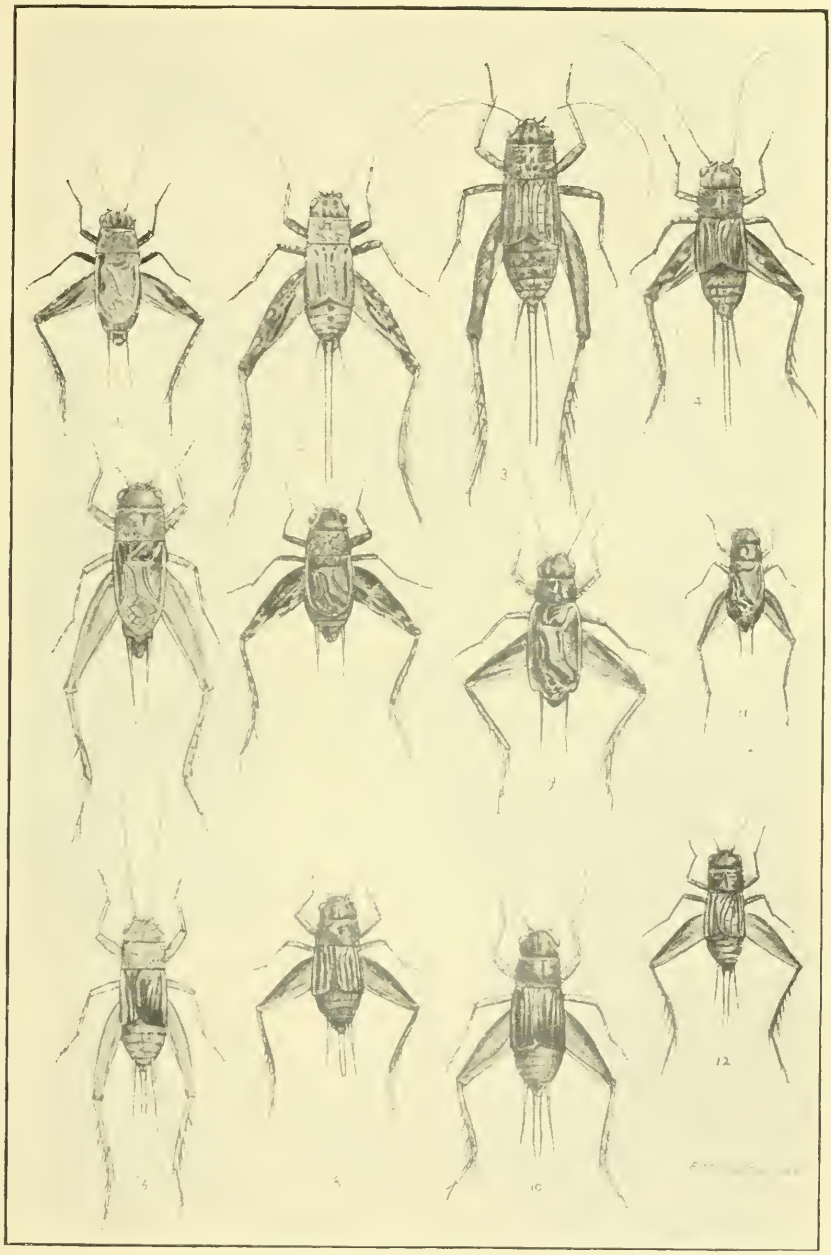


PLATE 17.

Tree-crickets, *Oecanthus* spp.

Fig. A. Pine Tree-cricket, *Oe. pini.* Fifth-stage nymph.
Fig. B. Broad-winged Tree-cricket, *Oe. latipennis.* Fifth-stage nymph. (An extra limital species.)
Fig. C. Dusky Tree-cricket, *Oe. nigricornis.* Adult male.

From B. B. Fulton, "The Tree-crickets of New York." Tech. Bull. N. Y. Agric. Exp. Sta., no. 42, pl. 4, 1915.

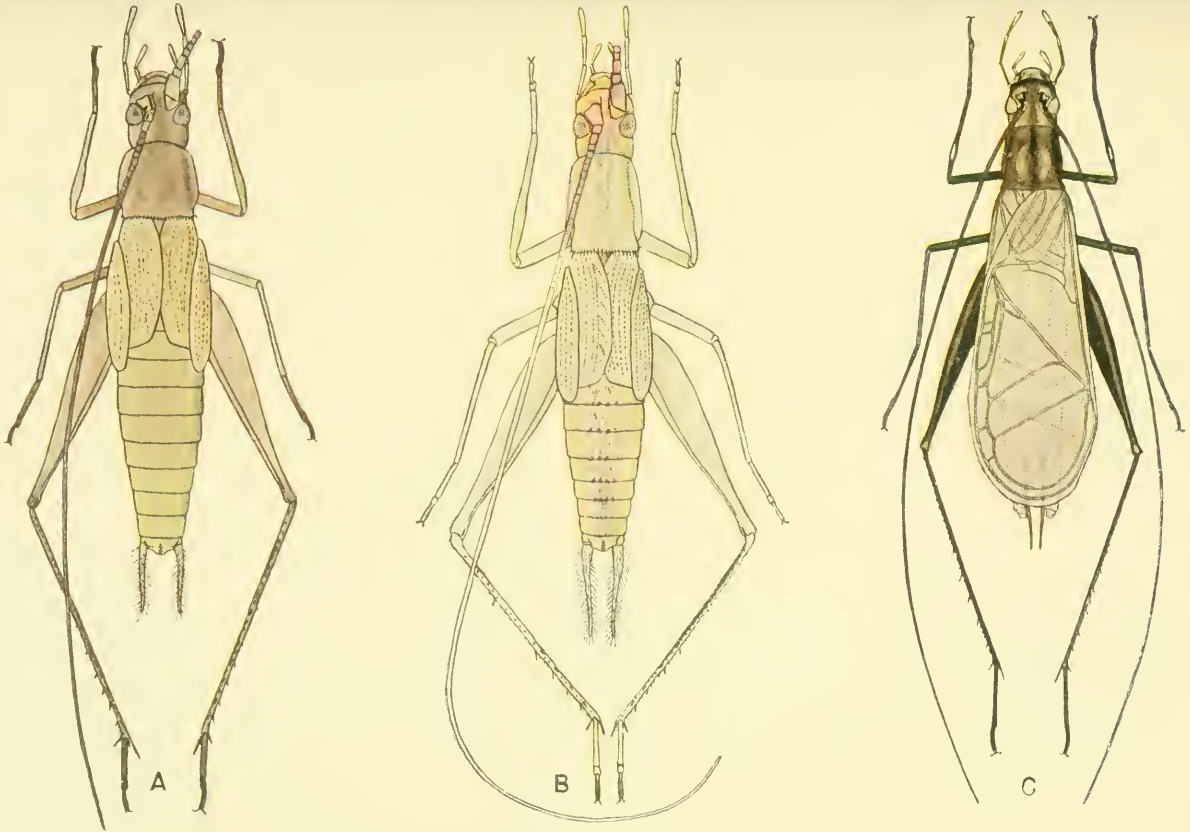

A
B
C

PLATE 18.

Tree-crickets, *Oecanthus* spp.

Fig. A. Snowy Tree-cricket, *Oe. niveus*. Adult male.
Fig. B. Davis' Tree-cricket, *Oe. exclamationis*. Adult male.
Fig. C. Narrow-winged Tree-cricket, *Oe. angustipennis*. Adult male.
Fig. D. Four-spotted Tree-cricket, *Oe. quadripunctatus*. Adult male.

From B. B. Fulton, "The Tree-crickets of New York." Tech. Bull. N. Y. Agric. Exp. Sta., no. 42, pl. 5, 1915.

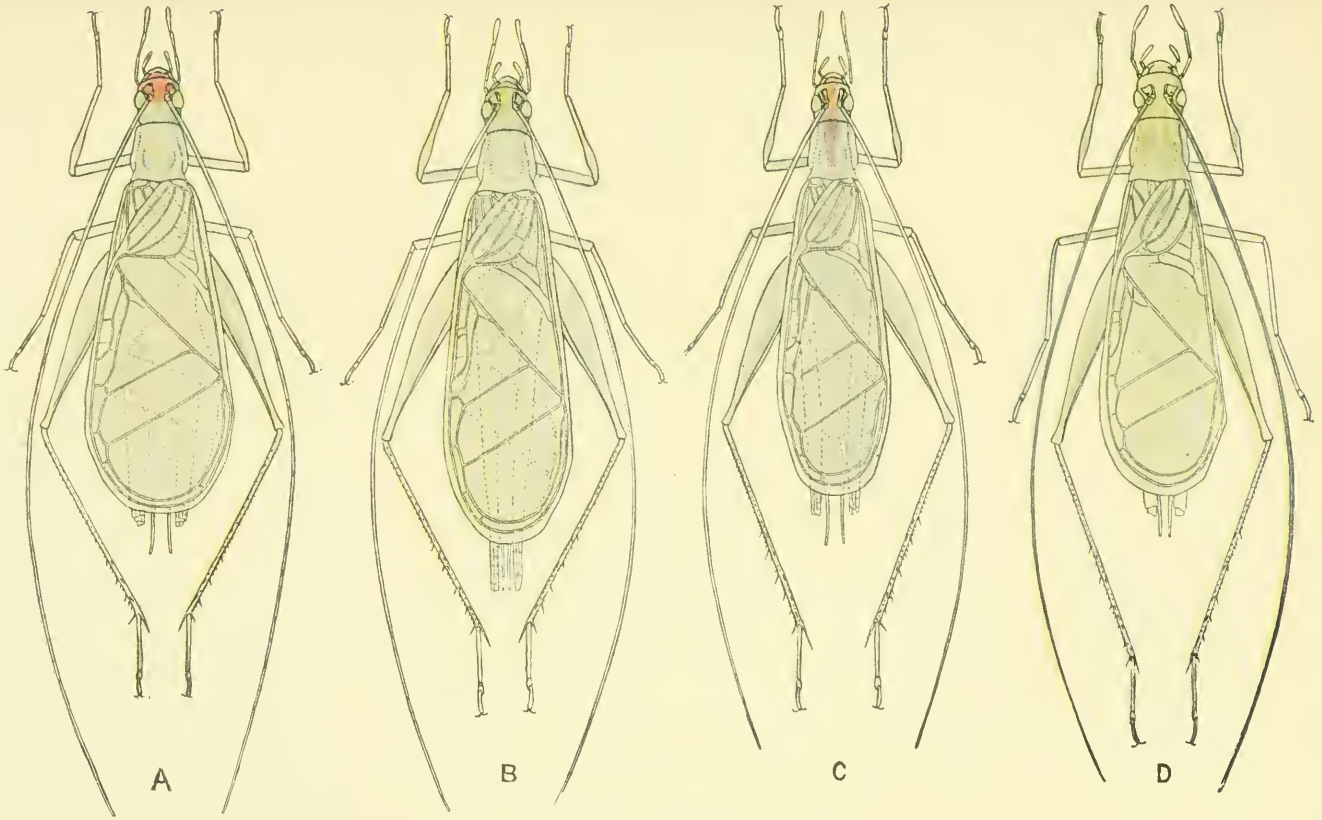

A
B
C
D

PLATE 19.

Fig. A. Pine Tree-cricket, *Oe. pini*. Adult male.

Fig. B. Broad-winged Tree-cricket, *Oe. latipennis*. Adult male. (An extra-limital species.)

From B. B. Fulton, "The Tree-crickets of New York." Tech Bull. N. Y. Agric. Exp. Sta., no. 42, pl. 6, 1915.

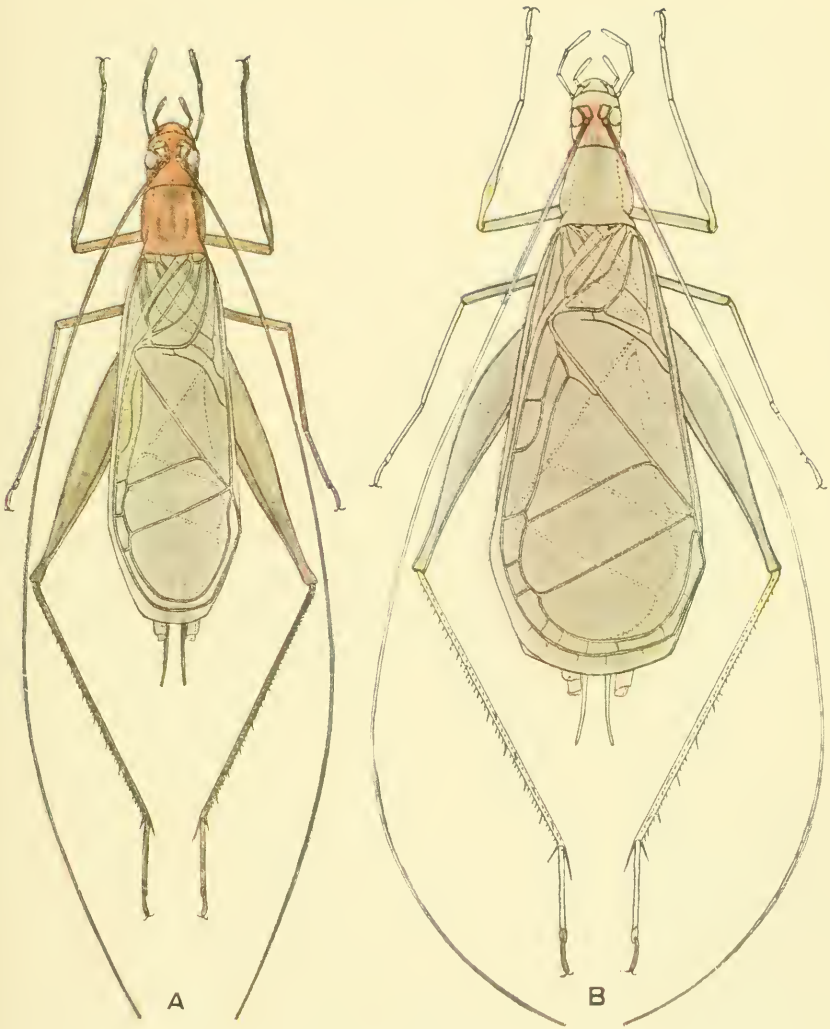

A
B

PLATE 20.

New England Acridinae: Details in outline.

Fig. 1. Bunch-grass Locust, *Pseudopomala brachyptera*. Female. Antenna.
Fig. 2. Same, male, tip of abdomen from beneath.
Fig. 3. Same, female, tip of abdomen from side.
Fig. 4. Bicolored Locust, *Dichromorpha viridis*. Male. Pronotum from above.
Fig. 5. Same, pronotum from side.
Fig. 6. Spotted-winged Locust, *Orphulella pelidna*. Female. Head from side.
Fig. 7. Same, pronotum from above.
Fig. 8. Same, male, head from above.
Fig. 9. Same, female, pronotum from side.
Fig. 10. Same, female, tegmen, discoidal and ulnar areas.
Fig. 11. Same, female, wing.
Fig. 12. Pasture Locust, *Orphulella speciosa*. Female. Pronotum from above.
Fig. 13. Same, male, head from above.
Fig. 14. Same, male, tegmen, discoidal and ulnar areas.
Fig. 15. Same, female, tegmen, discoidal and ulnar areas.
Fig. 16. Salt-marsh Locust, *Orphulella olivacea*. Female. Pronotum from above.
Fig. 17. Same, male, head from above.
Fig. 18. Sprinkled Locust, *Chloealtis conspersa*. Male. Tegmen.
Fig. 19. Same, female, tip of abdomen from side.
Fig. 20. Short-winged Meadow Locust, *Chorthippus curtipennis*. Female. Head from above.
Fig. 21. Striped Sedge-locust, *Mccostethus lineatus*. Female. Disk of pronotum.
Fig. 22. Same, male, tegmen.
Fig. 23. Same, male, teeth of rasp.
Fig. 24. Northern Sedge-locust, *Mecostethus gracilis*. Male. Teeth of rasp.
Fig. 25. Broad-winged Sedge-locust, *Mecostethus platypterus*. Female. Disk of pronotum.
Fig. 26. Same, male, intercalary venules.
Fig. 27. Same, male, tip of abdomen from below.

Abbreviations.

a. u. v. = anterior ulnar vein,—15, 22, 26.
b. r. v. = branches of radial vein,—11.
d. a. = discoidal area,—15.
d. v. = depression of vertex,—8, 17.
f. = foveola,—6, 20.
i. v. = intercalary vein,—22, 26.
i. vl. = intercalary venules,—22, 26.
mz. = metazone,—25.
p. u. v. = posterior ulnar vein,—15, 22.
pz. = prozone,—25.
r. v. = radial vein,—11, 15, 18.
sc. a. = scapular area,—18, 22.
sp. v. = spurious vein,—10, 11.
u. a. = ulnar area,—10, 15.

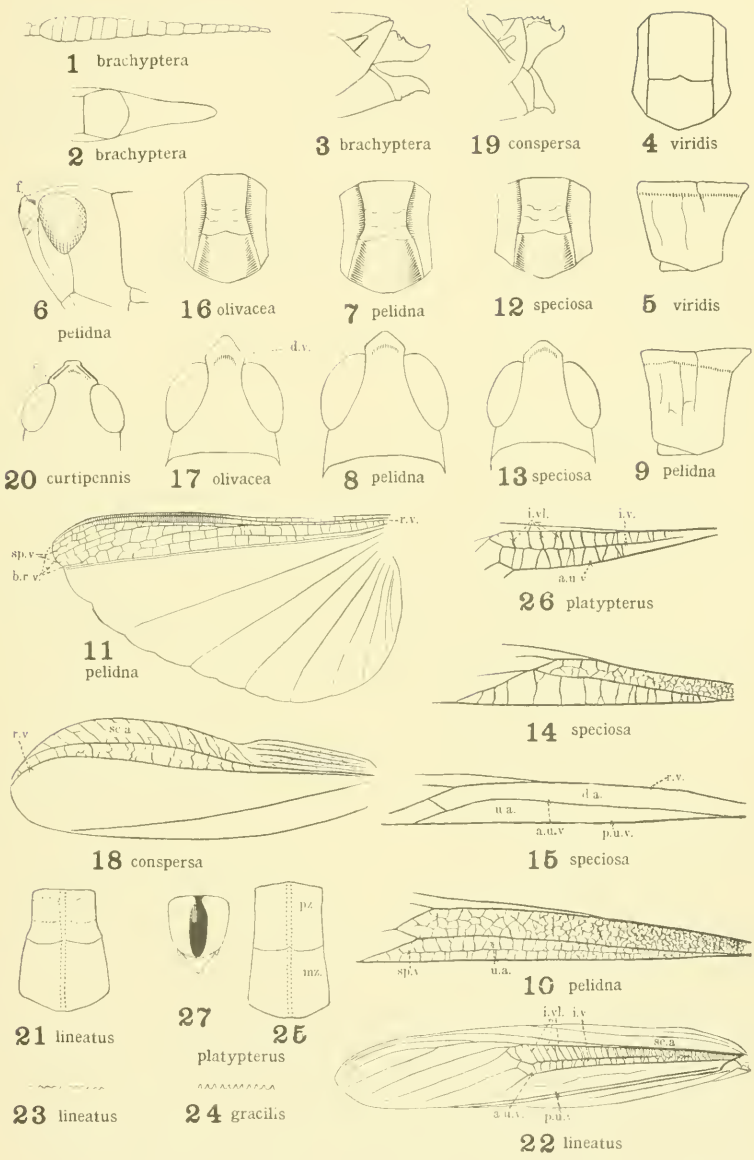

1 brachyptera
2 brachyptera
3 brachyptera
19 conspersa
4 viridis
6 pelidna
16 olivacea
7 pelidna
12 speciosa
5 viridis
20 curtipennis
17 olivacea
8 pelidna
13 speciosa
9 pelidna
11 pelidna
26 platypterus
14 speciosa
18 conspersa
15 speciosa
21 lineatus
27
25
platypterus
10 pelidna
23 lineatus
24 gracilis
22 lineatus

PLATE 21.

New England Oedipodinae: Details in outline.

Fig. 1. Autumn Yellow-winged Locust, *Arphia xanthoptera*. Male. Pronotum from side.
Fig. 2. Same, head from above.
Fig. 3. Spring Yellow-winged Locust, *Arphia sulphurea*. Male. Pronotum from side.
Fig. 4. Green-striped Locust, *Chortophaga viridifasciata*. Male. Part of wing.
Fig. 5. Same, part of tegmen.
Fig. 6. Dusky Locust, *Encoptolophus sordidus*. Male. Tegmen, in part.
Fig. 7. Clear-winged Locust, *Camnula pellucida*. Male. Part of wing.
Fig. 8. Same, part of tegmen.
Fig. 9. Coral-winged Locust, *Pardalophora apiculata*. Female. Head and pronotum from side.
Fig. 10. Same, male, wing.
Fig. 11. Wrinkled Locust, *Hippiscus rugosus*. Female. Head and pronotum from side.
Fig. 12. Scudder's Wasteland Locust, *Spharagemon collare scudderi*. Female. Pronotum from above.
Fig. 13. Same, pronotum from side.
Fig. 14. Ledge Locust, *Spharagemon saxatile*. Female. Pronotum from above.
Fig. 15. Same, pronotum from side.
Fig. 16. Boll's Locust, *Spharagemon bolli*. Female. Pronotum from above.
Fig. 17. Same, pronotum from side.
Fig. 18. Same, head and pronotum from above.
Fig. 19. Same, head and pronotum from side.
Fig. 20. Marbled Locust, *Scirtetica marmorata*. Female. Head and pronotum from above.
Fig. 21. Same, head and pronotum from side.
Fig. 22. Same, male, tegmen, distal part.
Fig. 23. Sand Locust, *Psinidia fenestralis*. Male. Tegmen, distal part.
Fig. 24. Seaside Locust, *Trimerotropis maritima*. Female. Pronotum from above.
Fig. 25. Snapping Locust, *Circotettix verruculatus*. Male. Wing.

Abbreviations.

B. = base of wing,—10.
D. = disk of wing,—10.
d. a. = discoidal area,—6, 7.
h. p. = hind process of pronotum,—24.
i. v. = intercalary vein,—6.
mz. = metazone,—9, 20.
pz. = prozone,—9, 20.
r. v. = radial vein,—6.
s. v. = scutellum of vertex,—18.
sf. s. = subfrontal shoot,—10.
u. a. = ulnar area,—6, 7.
u. v. = ulnar vein,—6.
v. = vertex,—9.

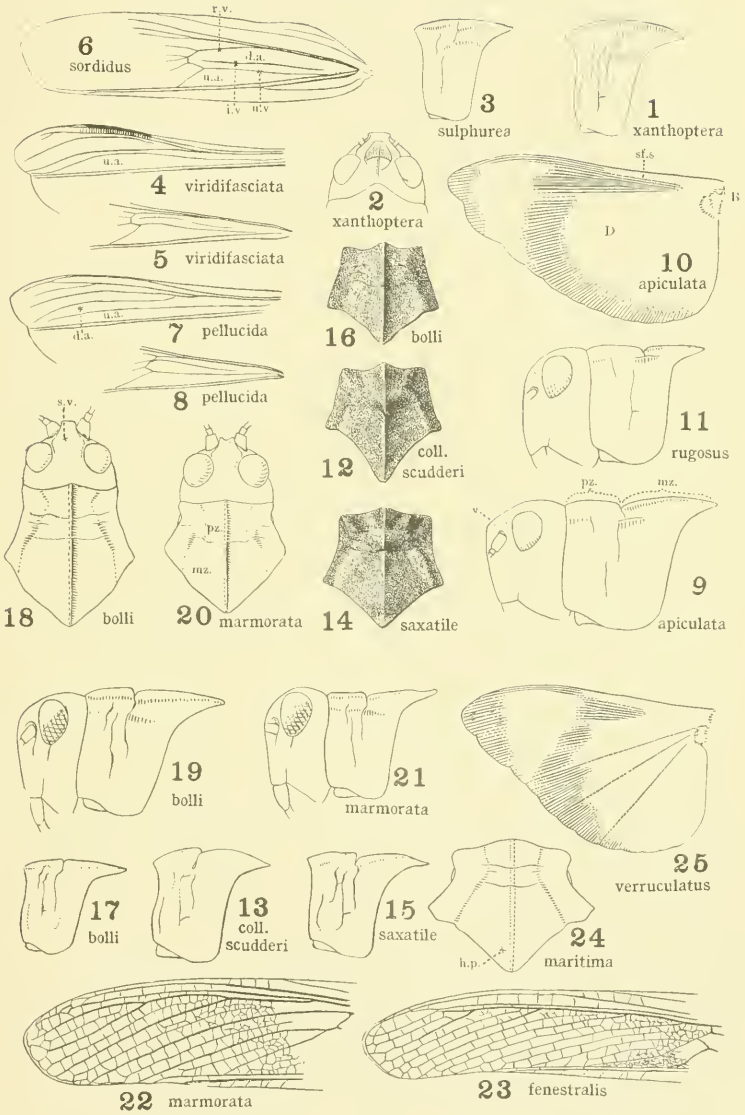

6
sordidus
r.v.
d.a.
u.a.
i.v
n.v
3
sulphurea
1
xanthoptera
4 viridifasciata
u.a.
2
xanthoptera
sf.s
B
D
10
apiculata
5 viridifasciata
7 pellucida
u.a.
d.a.
16 bolli
8 pellucida
11
rugosus
s.v.
12
coll.
scudderi
pz.
mz.
18 bolli
20 marmorata
14 saxatile
9
apiculata
19
bolli
21
marmorata
25
verruculatus
17
bolli
13
coll.
scudderi
15
saxatile
24
maritima
h.p.
22 marmorata
23 fenestralis

PLATE 22.

Fig. 1. Rusty Locust, *Schistocerca alutacea rubiginosa*. Male. Head and pronotum from above.
Fig. 2. Rusty Locust, *Schistocerca alutacea alutacea*. Male. Head and pronotum from above.
Fig. 3. Lesser Migratory Locust, *Melanoplus mexicanus atlanis*. Male. Cercus.
Fig. 4. Same, female. Ovipositor.
Fig. 5. Same, male. End of abdomen from rear.
Fig. 6. Same, female. Pronotum from side.
Fig. 7. Same, female. Prosternal spine from front.
Fig. 8. Red-legged Locust, *Melanoplus femur-rubrum*. Male. Cercus.
Fig. 9. Same, female. Ovipositor.
Fig. 10. Same, female. Meso- and metasterna; interspace longitudinal.
Fig. 11. Same, male. Furcula from above.
Fig. 12. Same, female. Prosternal spine from front.
Fig. 13. Northern Locust, *Melanoplus borealis extremus*. Male. Cercus.
Fig. 14. Same, female. Ovipositor.
Fig. 15. Little Locust, *Melanoplus confusus*. Male. Cercus.
Fig. 16. Same, female. Ovipositor.
Fig. 17. Broad-necked Locust, *Melanoplus luridus*. Male. Cercus.
Fig. 18. Same, female. Ovipositor.
Fig. 19. Same, female. Pronotum from side.
Fig. 20. Yellow-striped Locust, *Melanoplus bivittatus*. Male. Cercus.
Fig. 21. Pine-tree Locust, *Melanoplus punctulatus*. Male. Cercus.
Fig. 22. Same, female. Ovipositor.
Fig. 23. Huckleberry Locust, *Melanoplus fasciatus*. Male. Cercus.
Fig. 24. Same, female. Meso- and metasterna; interspace transverse.
Fig. 25. Scudder's Short-winged Locust, *Melanoplus scudderi*. Male. Cercus.
Fig. 26. Same, female. Pronotum from side.
Fig. 27. Same, female. Tegmen of left side.
Fig. 28. Smith's Locust, *Melanoplus mancus*. Male. Cercus.
Fig. 29. Same, female. Pronotum from side.
Fig. 30. Same, female. Tegmen of left side.
Fig. 31. Same, male. Furcula from above.

Abbreviations.

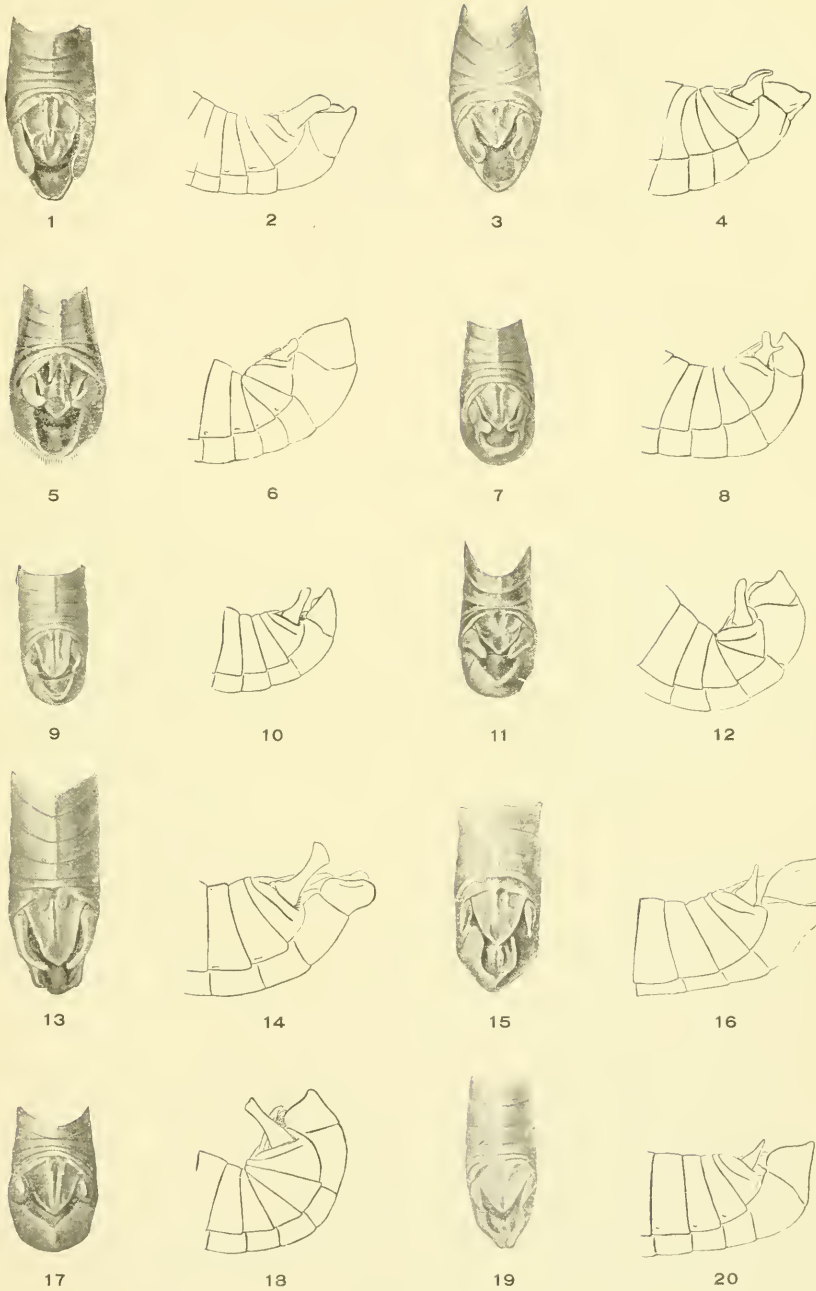
Ang. = Angulation at base of scoop of ovipositor,—9, 16.
C. = cercus of female,—9.
F. = furcula,—11.
I. = interspace between mesosternal lobes,—24.
L. l. = lateral lobe of pronotum,—26.
L. v. = lower valve of ovipositor,—9.
P. s. = principal sulcus,—6.
Sc. = scoop of ovipositor,—9, 16.
Sg. p. = subgenital plate of male,—5.
U. v. = upper valve of ovipositor,—9.
V. = vertex of head,—1.

20 bivittatus
1 rubiginosa
2 alutacea
26 scudderi
21 punctulatus
31 mancus
29 mancus
11 femur-rubrum
8 femur-rubrum
30 mancus
19 luridus
3 atlanis
27 scudderi
24 fasciatus
6 atlanis
13 extremus
28 mancus
12 femur-rubrum
25 scudderi
5 atlanis
10 femur-rubrum
7 atlanis
23 fasciatus
14 extremus
18 luridus
16 confusus
15 confusus
9 femur-rubrum
4 atlanis
22 punctulatus
17 luridus

PLATE 23.

Dorsal and lateral views of terminal abdominal segments of male Locusts (from Scudder, Proc. U. S. Nat. Mus., vol. 20, 1897).

Figs. 1, 2. Banded Locust, *Melanoplus fasciatus.*
Figs. 3, 4. Little Locust, *M. confusus.*
Figs. 5, 6. Northern Meadow Locust, *M. borealis extremus.*
Figs. 7, 8. Broad-necked Locust, *M. luridus.*
Figs. 9, 10. Smith's Locust, *M. mancus.*
Figs. 11, 12. Green-legged Locust, *M. viridipes.*
Figs. 13, 14. Swamp Locust, *Paroxya clavuliger.*
Figs. 15, 16. Large-headed Locust, *Phoetaliotes nebrascensis.*
Figs. 17, 18. White Mountain Wingless Locust, *Podisma glacialis glacialis.*
Figs. 19, 20. Purple-striped Locust, *Hesperotettix brevipennis.*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15
16
17
18
19
20

PLATE 24.

New England Pygmy Locusts: Details.

Fig. 1. Crested Pygmy Locust, *Nomotettix cristatus*. Side view of pronotum.
Fig. 2. Same, caudate form.
Fig. 3. Same, section through pronotum.
Fig. 4. Same, head from side.
Fig. 5. Same, head from above.
Fig. 6. Ornate Pygmy Locust, *Acrydium ornatum*. Outlines of normal and abbreviate forms from above.
Fig. 7. Same, side view of sinuses of lateral lobe of pronotum.
Fig. 8. Same, head from above.
Fig. 9. Same, head from side.
Fig. 10. Same, left middle femur.
Fig. 11. Hancock's Pygmy Locust, *Acrydium hancocki*. Left middle femur.
Fig. 12. Obscure Pygmy Locust, *Acrydium arenosum angustum*. Head from above.
Fig. 13. Angulate Pygmy Locust, *Acrydium granulatum*. Head from above.
Fig. 14. Same, head from side.
Fig. 15. Hooded Pygmy Locust, *Paratettix cucullatus*. Head from above.
Fig. 16. Same, head from side.
Fig. 17. Sedge Pygmy Locust, *Tettigidea lateralis*. Head from above.

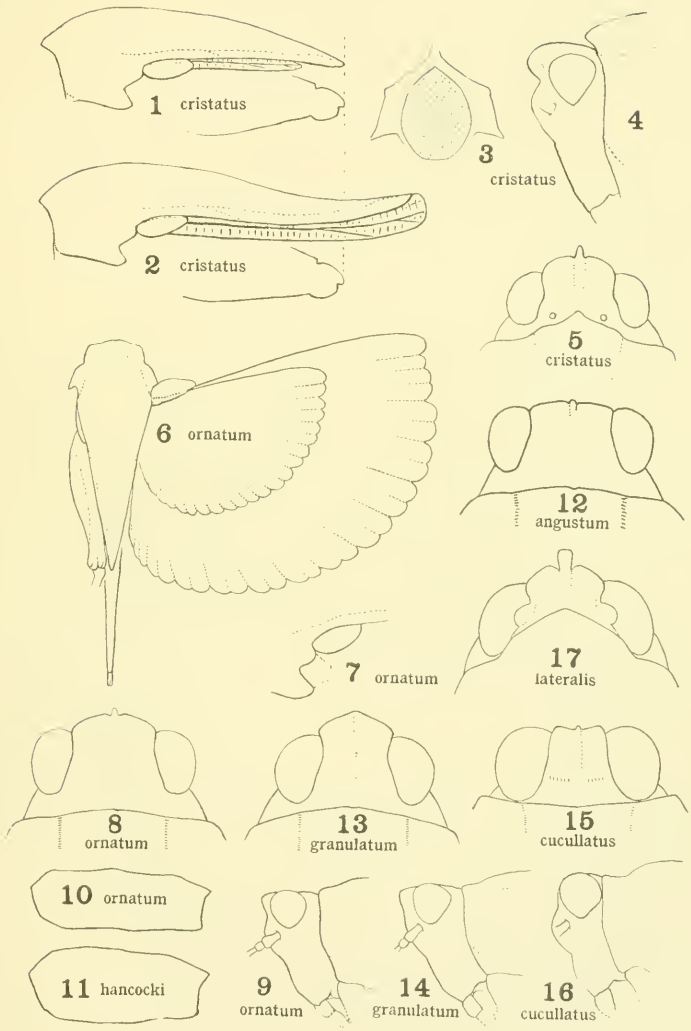
1 cristatus
2 cristatus
3 cristatus
4
5 cristatus
6 ornatum
7 ornatum
8 ornatum
10 ornatum
11 hancocki
9 ornatum
12 angustum
13 granulatum
14 granulatum
15 cucullatus
16 cucullatus
17 lateralis

PLATE 25.

Protective coloration ("camouflage") in the Ledge Locust, *Spharagemon saxatile*, showing several Locusts on their natural background; one flying, four at rest.

Photographed from an exhibit in the Peabody Museum of Salem, Mass., prepared by the author from material secured at Legg's Hill, Salem.

PLATE 26.

Fig. 1. A winter habitat. Young Green-striped Locusts (*Chortophaga viridifasciata*) were hopping actively about within a foot of the snow in January. Wellesley, Mass.

Fig. 2. Pine-tree Locust (*Melanoplus punctulatus*) laying eggs in crack of fire-scarred trunk of white pine. Dover, Mass.

1

2

PLATE 27.

Oviposition of the Pine-tree Locust, *Melanoplus punctulatus*.

Fig. 1. Piece of bark of white pine showing exit-hole of borer through which a Locust laid eggs in empty burrow shown in Fig. 2.
Fig. 2. Burrow of pine-borer filled with the egg-mass of Pine-tree Locust.
Fig. 3. Another exit-hole in which locust eggs have been laid, its opening surrounded by a dark-brown cementing mass.
Fig. 4. Under side of piece of loose pine bark showing exit-hole of borer and three radiating egg-masses laid through it.
Fig. 5. Pupation-cell of ribbed pine-borer (*Rhagium lineatum*) filled with egg-masses laid through exit-hole. A few eggs show distinctly.
Fig. 6. Three eggs of Pine-tree Locust.

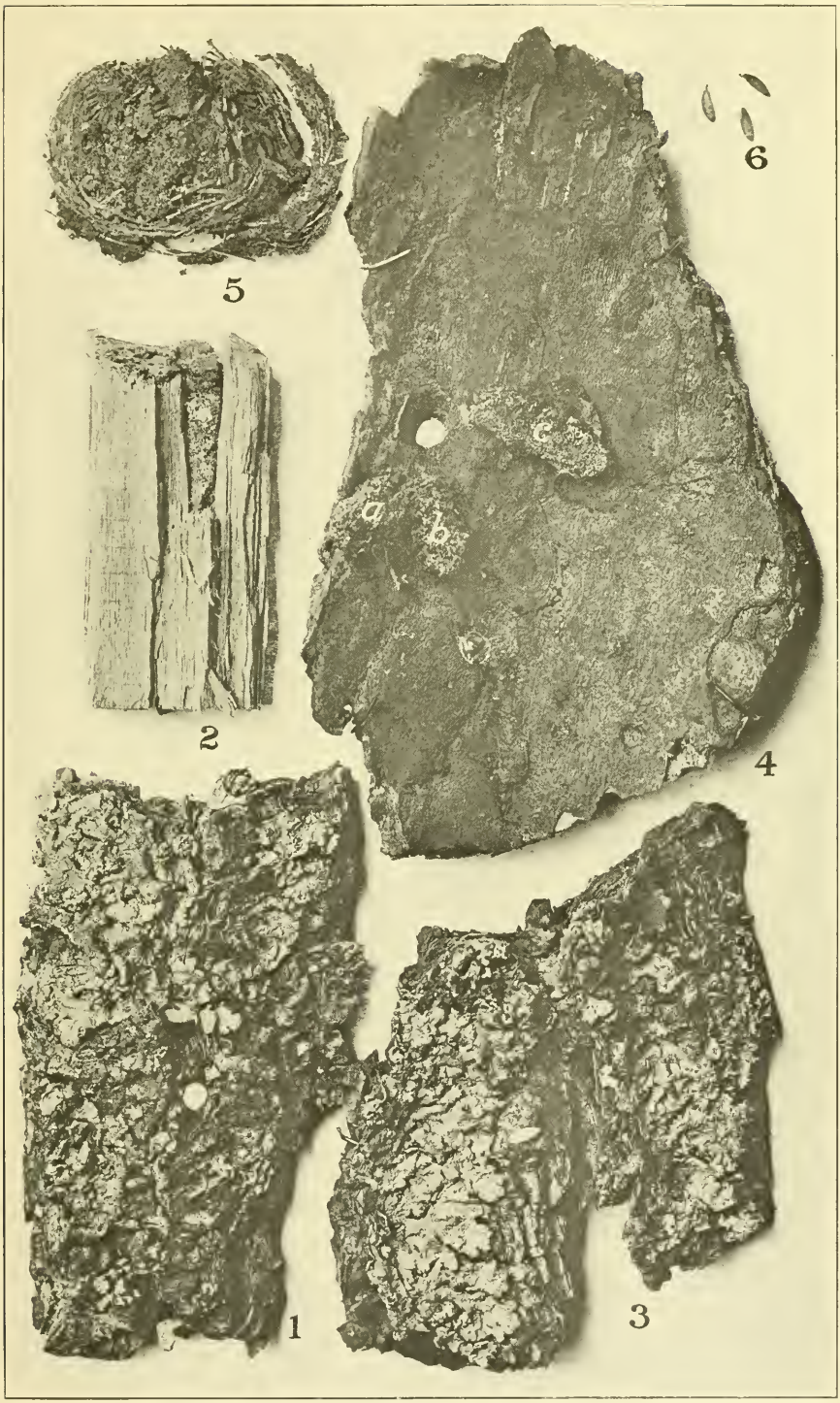
5
6
a
b
c
2
4
1
3

PLATE 28.

Typical Locust Habitats.

Fig. 1. Ledge habitat of Snapping Locust (*Circotettix verruculatus*); thicket habitat of Smith's Locust (*Melanoplus mancus*) and Huckleberry Locust (*Melanoplus fasciatus*). Mt. Everett, Mass.

Fig. 2. Stream-margin habitat of Hooded Pygmy Locust (*Paratettix cucullatus*). Alstead, N. H.

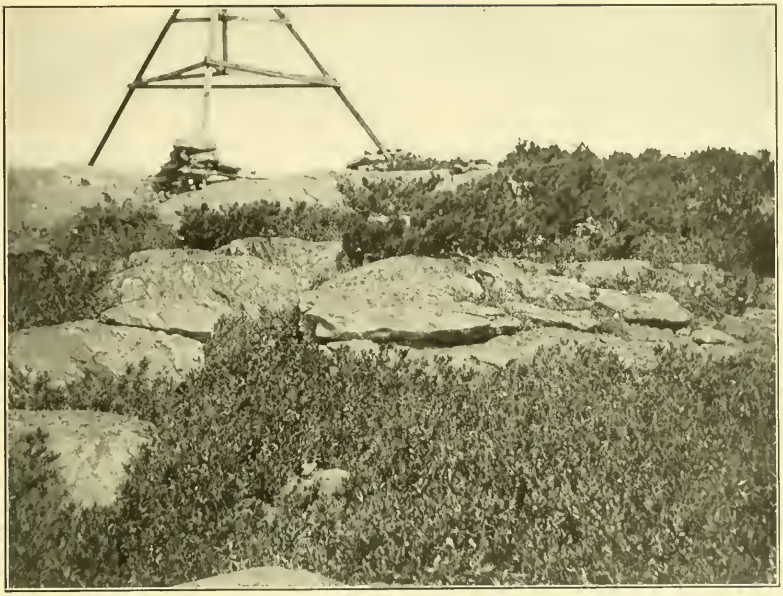

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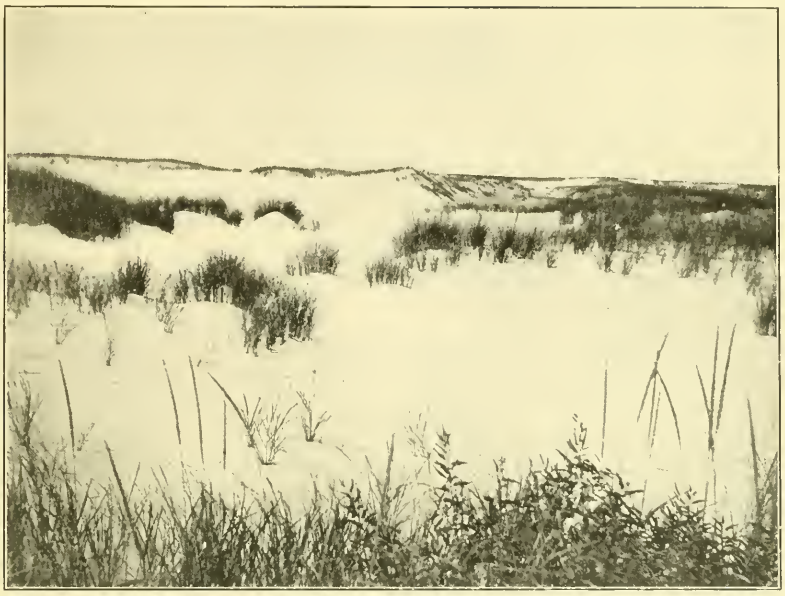
PLATE 29.

Typical Locust Habitats.

Fig. 1. Dune habitat of Sea-side Locust (*Trimerotropis maritima*). Provincetown, Mass.

Fig. 2. Wet sedge-meadow habitat of Striped Sedge-locust (*Mecostethus lineatus*). Sherborn, Mass.



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